CAN PATIENT SELF-MANAGEMENT HELP EXPLAIN THE SES HEALTH GRADIENT?*

Dana P. Goldman, Ph.D.

James P. Smith, Ph.D.

RAND
1700 Main Street
Santa Monica, California 90407

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Dr. James P. Smith is the corresponding author- phone 310-451-6925; fax 310-451-6935; email smith@rand.org.

In recent years, there has been renewed interest in why people of lower Social-Economic status (SES) have worse health outcomes. No matter which measures of SES (income, wealth or education) are used, the evidence that this association is large and pervasive across a variety of health outcomes such as mortality or morbidity is abundant [1, 2]. However, considerable debate remains about why the relation arises. The traditional arguments— that the less well-to-do have access to less [3, 4] or lower quality [5] medical care or exhibit a stronger pattern of deleterious personal behaviors such as smoking and excess drinking—are seen as incomplete. Recently, some intriguing theories have arisen that emphasizes long-term impacts of early childhood or even inter-uterine environmental factors [6, 7] or the cumulative effects of prolonged exposures to individual stressful events [8]. While these may be important reasons for part of the SES health relationship, we investigate here another mechanism—the ability of individuals across different SES levels to comply with and maintain complex health regimens that are often prescribed to deal effectively with severe health problems.

Many efficacious therapies now hold considerable promise in either delaying disease progression or mitigating health consequences. However, the treatment regimens often require high quality and persistent patient self-management on a daily basis, and not all patients are equally adept at complying. In clinical practice, adherence rates can be as low as 20%, although the rate varies with complexity [9] and duration of therapy [10]. Compliance requires an understanding of medical necessity and an ability to select the most appropriate regimens. It also requires a willingness to internalize the future costs of incomplete compliance. Since education serves as a proxy for many of these personal traits, schooling may play a key role in explaining health outcomes for those with chronic illness, but this link has not been fully explored.

This paper investigates the role of adherence to self-treatment regimens in creating and maintaining a steep gradient between an individual's education and his health. In our evaluation, we place special emphasis on the treatments for two diseases—HIV and insulin dependent diabetes. Both represent diseases where recommended treatments are potentially highly efficacious. However, they represent very different patient populations, and they differ in the role of patient judgment. New antiretroviral therapies have been shown to reduce mortality in HIV+ patients [11]. While much more effective than previous methods of treating HIV, these treatments are complex—often involving over two dozen pills, tablets or capsules a day where the timing and order in which one takes pills must be carefully synchronized with meals and with each other [12].

Successful management of diabetes typically involves fewer medications than HIV, but it requires more judgment about the appropriate level of glucose-medication titration. Clinical trials consistently show that the complications from this disease can be avoided or deferred with tight glycemic control [13]. This makes extensive self-management important, including frequent monitoring of blood glucose levels, balancing dosages with food intake and physical activity, prevention and treatment of hypoglycemia, and regular consultation with health care providers.

Despite these differences in treatment, we show that both HIV and diabetes demonstrate large differences in adherence by education groups, and these differences affect overall health status. Further, we demonstrate that these differences are quite robust, appearing in both observational studies of patients with chronic illness and also in the regimented context of a randomized clinical trial. Most importantly, we demonstrate that these SES disparities can be altered through clinical interventions.

METHODS

Data

To test the effects of education on HIV treatment regimens and outcomes, we use data from the HIV Cost and Services Utilization Study (HCSUS). The study has been described in detail elsewhere [14]. Briefly, the HCSUS employed a multi-stage national probability sample design to obtain a representative sample of adult patients in care. For each sampled patient, the study attempted to conduct three rounds of interviews between January 1996 and January 1998. We use data from the baseline (n=2864) and final round (n=2267), and identified patients receiving highly active antiretroviral therapy

(HAART) using the definition provided by Andersen et al. [15]. Their definition is based on recommendations published by the Centers for Disease Control and Prevention [16] and includes patients receiving various combinations of protease inhibitors, nucleoside reverse transcriptase inhibitors, and non-nucleoside reverse transcriptase inhibitors.

In the final round, patients were asked to list every HIV medication they were taking, and to report for each medication, how many days in the past week they adhered to its prescribed regimen. Given the potential consequences of non-compliance, we consider a patient adherent only if—for every medication taken—he reported taking it for seven of the past seven days. This approach to measuring adherence has been significantly associated with viral load [17]. To assess the impact on health, we primarily consider changes in general health. We rely on self-reported general health status as measured on a five point ordinal scale from excellent to poor. This scale is a widely accepted measure of general health status [18] and is known to be highly predictive of future objectively measured health outcomes [19].

For diabetes, we utilize two important surveys—the Health and Retirement Survey (HRS) and the Diabetes Control and Complications and Trial (DCCT). HRS is a high quality general-purpose longitudinal social science survey while the DCCT is a randomized perspective clinical diabetes trial. These studies have complimentary strengths that combined help elucidate the critical role of self-adherence in diabetes treatment. HRS is a national probability sample of 12,650 men and women born between January 1, 1931 and December 31, 1941 (ages 51-61 in 1992) and their spouses. The overall response rate was 80%. HRS's main objective is to monitor interactions between economic status and health outcomes during and after the transition to retirement. Follow-ups of HRS respondents were fielded at two-year intervals, and the first four waves of the survey are used here. The survey included questions on demographics, income and wealth, family structure, employment, and cognition. Questions were asked in each wave about self-reports of general health status, the prevalence and incidence of many chronic conditions, and types of medical treatments followed. Individuals with diabetes are asked if they are taking any medication that they swallow and whether they were using insulin shots or a pump.

The DCCT was a randomized prospective clinical trial examining the effectiveness of intensive treatment of diabetes mellitus in preventing or delaying complications from disease [13]. Between 1983 and 1989, the DCCT enrolled a total of 1,441 patients aged 13 to 39 years who had insulin-dependent diabetes mellitus for one to fifteen years; and no hypertension, hypercholesterolemia, or severe diabetic complications or medical conditions. These patients were randomized to either an intensive or conventional therapy and were followed through April 1993. Such randomization has the traditional benefit of measuring the effectiveness of a new treatment. Since the assignment to treatment was random by education groups, it allows us to estimate the differential impact of an enforced effective treatment across patients in different SES groups. It is that aspect of randomization that we utilize in our analysis.

Standard therapy consisted of one or two injections of insulin per day with daily self-monitoring of blood glucose, a schedule of clinic visits, and monitoring procedures every three months. Intensive therapy included insulin injections three or more times daily or an external pump. The dosage was adjusted based on the results of self-monitoring at least four times per day, dietary intake, and anticipated exercise. Subjects were seen weekly at the clinic until a stable treatment program was achieved and at least monthly thereafter. Telephone contact was made daily for the first week and weekly thereafter.

Analysis of Treatment Adherence

We used probit regression to assess the impact of years of schooling—categorized as 12, 13-15, or 16 or more years of schooling with less than 12 years of schooling the excluded category—on adherence to HAART as measured by whether a patient took his medication properly for seven of the past seven days and health outcomes. Probit regression assumes the distribution of the underlying model error is normal, and is well suited to models with categorical responses [20]. It is very similar to logistic regression when the response variable is binary, but it extends more readily to responses with more than two possible outcomes—our situation for changes in health. The models also control for baseline measures of general health (excellent or very good, good, fair, or poor); baseline measures of self-reported lowest CD4+ lymphocyte count from patient self-reports (less than 50 cells per mm^3, 50-199 cells, 200-499 cells, and 500+ cells), health insurance status, census region, age, race, sex, exposure route (intravenous drugs or homosexual male), and income.

For diabetics in the HRS, we classified treatment patterns over the waves as "good" or "bad" regimens and ran a probit regression to investigate how years of schooling (categorized as for HIV) affected treatment. The regression included demographic controls (female, black, and Hispanic), and birth cohort (post 1937, 1935-1937, and pre 1937). Marital status and gender interactions where included to test whether marriage conferred some benefit in terms of better treatment. We estimated the model with and without the Wechsler Adult Intelligence Score (WAIS), a measure of higher-level reasoning to examine whether cognitive ability mediated adherence differences by education group.

Several simple rules were used in making the determination of "good" or "bad" in the HRS. If a respondent maintained the same regimen over all three waves—taking nothing, taking medication only, taking insulin only, or taking both—the treatment was considered good. These regimens accounted for the majority of good regimens. The remaining good behaviors included patients who started on medication but ended up on insulin, under the presumption the disease had progressed. Bad behaviors typically took two forms. In the first form, patients stopped their treatment—i.e., they report taking either medicine or insulin in one wave, and then reporting taking neither in a subsequent wave. Other patients reported switching from one treatment to another and then back to the original treatment—for example, taking insulin in one wave, then medication in a second wave, and then back to insulin. Finally, some poor treatment patterns, which occurred infrequently, consisted of patients who added a second regimen to their initial treatment; for example, adding a medication to an insulin regimen or vice-versa. We conducted sensitivity analyses by examining the association between education and good behavior under alternative definitions of "good". Our analyses were not sensitive to these changes.

Analysis of Health Outcomes

A basic issue is whether non-adherent or poor health maintenance behaviors have any impact on subsequent health outcomes. For HIV, we consider the impact of adherence on morbidity, since it is already well established that adherence affects viral load [(17)] and hence mortality [(21)]. For morbidity, we recorded whether patients' self-reported health got worse, stayed the same, or improved between the baseline and final round. This change in health status was then related to treatment (and adherence) by including two variables that measure whether the patient received HAART and whether the patient adhered to HAART. We also included schooling and the other factors used in the adherence analysis.

For diabetics in HRS, we examined the change in self-reported health between the first and forth round of HRS among those who had been diagnosed with diabetes by the baseline round of the survey. Using these two reports of self-rated health measured eight years apart, we estimated an ordered probit again recording whether self-reported health got worse, same the same, or improved. A variable indicating whether the respondent engaged in poor health maintenance behavior between these waves was included in the model. Since change in health outcome is naturally ordered and categorical, ordered probit estimation methods were used for both diseases [(20)]. In DCCT, we measure health outcomes with a more objective measure using hemoglobin A1c (glycosolated hemoglobin). This laboratory test measures the amount of sugar binding to the hemoglobin over the last two to four months with higher levels demonstrating worse control.

RESULTS

HIV

Table 1 illustrates the difference in patient-intensive treatment and some selected health outcomes across educational groups for the third round. Our measure of SES—years of schooling—is related both to the fraction using HAART and the fraction who adhere to the regimen. For example, 68% of college graduates use HAART, but only 54% of high school dropouts do so. Similarly, 57% of college graduates always adhere to their treatment regimens, while only 37% of high school dropouts do so. For these two adherence measures, all education groups above high school are statistically different than the lowest education category. The consequence of lower use of HAART and lower levels of adherence by the less educated is suggested by the differences in general health; the less educated are much more likely to report poor general health. Finally, changes in CD4 cell counts—a key measure of immune response (with higher levels meaning better function)—between baseline and second follow-up also vary systematically by education group.

Table 2 summarizes our analysis of the relationship of education on adherence to HAART and its subsequent impact on health. Even after controlling for disease status, insurance, income, and other factors, more educated patients are more likely to adhere to therapy. The magnitude of this effect is not trivial. For example, the estimated effect of college education relative to high school dropouts (0.308) is on par with the effect of being black or female, two groups often cited in the health disparities literature. It is important to note as well that education and not income is related to adherence behavior so that the impact of education on adherence is not operating through economic resources.

Second, strict adherence to the HAART therapeutic regimen and not simply being a HAART user was absolutely critical in achieving better health outcomes. The last three columns of Table 2 show that among those taking HAART, only strict adherence improved their self-reported health status. Importantly, education does not have a significant impact on health after we control for adherence. That is, the effect of education on health operates entirely through adherence. Moreover, there is also a strong linear relationship between linear years of schooling and mortality, which is substantially mediated by treatment adherence. In fact years of education is no longer a significant predictor of mortality once we control for treatment and adherence. Like our results for general health, we find that it is only treatment adherence that matters—treatment alone is not beneficial.

Diabetes—Results from a Population-based Survey

Table 3 shows general health status at baseline for all HRS respondents (top panel) by education level. Consistent with many studies, the steepness of the HRS health gradient is impressive—only one-third of those who did not graduate from high school reported themselves in either excellent or very good health compared to almost three-quarters of college graduates. Similarly, 36% of those in the lowest education category were reported in either fair of poor health compared to only six percent in the highest education group. Not surprisingly, the general frequency of bad health increases dramatically in the second panel of Table 3 that is confined to diabetics. Even among diabetics, the health gradient with schooling remains large—two-thirds of those who were not high school graduates self-reported in either fair or bad health compared to only about one-fifth of diabetics who were college graduates. This pattern suggests that severity of disease at baseline also declines with years of schooling.

There also exists a strong association between years of schooling and the overall prevalence of diabetes at baseline as well as with the new onset of this disease during the first four waves of the panel. For example, 12.4% of respondents who had 0-11 years of schooling suffered from diabetes at baseline, twice the rate observed among college graduates. Similarly during the first four waves of this survey, 7.9% of those with 0-11 years of schooling were newly diagnosed with diabetes, once again twice the rate of new onsets among college graduates.

Table 4 examines adherence to medical treatment among diabetics. For both medication and insulin, we divided respondents into three types—those who were always on that treatment, those who were never on the treatment, and those who were irregularly on the treatment. Within either type of treatment, there exists a steep negative gradient with years of schooling for switching behavior. For example, 48% of those with 0-11 years of schooling were classified as switchers in medication compared to 23% among college graduates. Similarly, 23% of diabetes with 0-11 years of schooling were classified as switchers for the use insulin or pump compared to only 16% of college-graduated diabetics.

Table 5 considers the impact of "bad" behavior on health status changes. Over an eight-year time frame, self-reported health among diabetics is less likely to deteriorate the higher the education of the respondent and among female diabetics, while minorities (African-Americans and Latinos) are more likely to experience a worsening health. Age effects are not strong because this sample is limited to respondents within a narrow age range (51-61 at baseline). Most importantly, those who followed a

’poor’ health regimen were much more likely to experience a negative health outcome. Once again, the magnitude of the health deterioration associated with a poor health regimen is not trivial. This effect is as large as that estimated as the difference between having less than a high school degree and being a college graduate and is on a par with the magnitude of the gender, race and ethnic effects.

What types of people follow poor health maintenance regimens? The results of our probit analysis of following a poor health regimen are summarized in Table 6. There appear to be no statistically significant gender, age, race, or ethnic differences in this behavior. However, we do find a statistically significant interaction between changes in marital status and being a male. Men who went from married to single were significantly less likely to maintain a good health regimen, suggesting that wives serve a protective role in helping men adhere to a good health regimen. Married men appear to offer no parallel protection for their wives. In supplementary analysis, we tested whether the significance of a wife varied by education by interacting the married-single variables with the 0-11 education group. These results indicate that the presence of a wife was more beneficial for more educated men, an indication that this is another advantage held by the more educated.

We estimate that more schooling reduces the likelihood of following a poor health regimen. The second model in Table 6 attempts to address the question of why education might matter. This model adds the respondent’s Wechsler Adult Intelligence Score (WAIS), measured in the baseline wave of the survey. This score is not only statistically significant, but in fact fully captures the education effects, as education no longer has any statistically significant independent effect. WAIS is a test that is geared to higher-level reasoning. The WAIS similarities subtest requires verbal concept formation, abstract reasoning abilities, flexible thinking, and inductive reasoning [(22)]. Other tests available in the HRS related to memory ability were also included in this model but they had no influence on adherence and did not affect the education gradient. The source of the association with SES does not appear to be economic resources, but rather the individual's ability at higher-level reasoning. It would be important in future research to expand the cognitive measures beyond the WAIS score available in HRS. While intriguing, our findings regarding cognitive ability should be viewed as suggestive until replicated in other studies.

Diabetes—Results from a Randomized Clinical Trial

In Table 7 we compare the self-management behaviors of the DCCT sample at baseline by education status. Across several dimensions, these patterns indicate that the more educated were more successful in monitoring and managing their disease. For example, the more educated were less likely to miss an insulin injection, but were more likely to follow their monthly insulin regimen and to self-test their blood or urine levels on a monthly basis. In addition, those with more a college education or more spend more minutes per week exercising at a moderate or intensive level, and were less likely to smoke.

This clinical trial, which imposes a rigid treatment regimen on those in the control group, is known to have produced improved glycemic control [(13)]. Our hypothesis is that imposing this intensive regime will have a larger impact on the less educated participants due to poorer self-maintenance in normal circumstances. This is a very stringent test of our hypothesis. Even in the DCCT there is a relatively homogenous treatment regimen for those in conventional therapy; they need to attend quarterly physical exams, meet with their treatment team, and of course, they are being treated in the same settings regardless of educational status. The patients are also highly motivated [(23)]. Thus, we expect the DCCT to understate the true effect of educational differences in self-maintenance on disease outcomes.

Table 8 considers the implications of being included in the rigid enforced regimen by examining differences in glycemic control across education groups in both the control and treatment samples. In the control group the primary endpoint of glycosylated hemoglobin shows a larger increase among the secondary school participants than those with at least some college education. This result is consistent with those found in the HRS that indicates that following ‘normal’ treatment regimen, health outcomes of the less educated diabetics will deteriorate at a more rapid rate. Serum blood glucose levels measured in the morning tell a similar story.

However, in the lower panel of Table 8, we see that there is very little gradient in outcome changes over time across educational group for those in the intensively treated arm. The impact of the enforcing a common treatment regime can be obtained by subtracting what normally would occur (the control sample) with what took place under an enforced treatment regimen (the treatment sample). These results, which are listed in the final row of Table 8, demonstrate that the enforced treatment had a much larger impact on less educated patients. This treatment effect is statistically significant. We also examined whether this treatment effect of the enforced behavioral regimen could be due to changes in smoking, physical exercise, both of which were strongly related to education at baseline (see Table 7). We estimated a series of models (not shown) to determine whether changes in smoking, exercise, or weight change were different in the treatment and control groups, and whether such differences emerged by education groups. There were no statistically significant differences between the treatment and control group at any education level in changes in smoking behavior or in vigorous exercise. There was actually a slight weight gain (3 lbs) among the less-educated treatment group compared to the less-educated controls. Therefore, changes in personal behaviors that are more conducive to better health outcomes appear not to be the reason for the improved health of the less-educated group in the treatment arm. Rather, the source of the improvement lies instead in better adherence to a medically superior regimen.

DISCUSSION

We have studied the ability of individuals across different SES levels to comply with and maintain complex health regimens that are often proscribed to deal effectively with severe health problems. For both diseases, the ability to maintain a better health regimen is an important independent determinant of subsequent health outcomes. Since this ability varies across schooling groups, self-maintenance is an important reason for the very steep SES gradient in health outcomes. This finding is quite robust to the population and the measure of health improvement.

We found similar results on the importance of adherence for diabetics and its relation to SES in two quite different types of studies. Containing rich background detail on respondents, HRS is a large representative national probability sample that easily generalizes to the population. HRS suffers from a lack of clinical detail and self-assignment of individuals to their treatment regimens. In contrast, the DCCT is a clinical trial with random assignment with much more detail on objective clinical outcomes associated with diabetes including laboratory measures of glycemic control. Yet, the ability to generalize from clinical trials is sometimes questioned since the participants are thought to be highly motivated. We believe that the similarity of our results on adherence in these two different types of studies adds great weight to the importance of adherence and its role in creating a SES health gradient.

A question arises whether our results generalize to other illnesses. HIV is an extremely serious illness with a quite complicated treatment and a relatively low prevalence in the population. But we also looked at diabetes, which is often considered the prototype for chronic disease management. Conditions where treatment requires continual patient judgment about when and how much to medicate, and the type of medicine, could show similar gradients. An example would be asthma, where patients need to respond to environmental factors and use drugs to manage acute symptoms. There are also analogies to treatments such as hypertension, although the differential impact of education may be muted as the drug regimen is not as complicated and the consequences of non-compliance are less severe.

Our research also suggests several explanations for why education matters. Good adherence to a treatment regimen requires several attributes that may be strongly related to education. First, a patient must be able to comply with physician orders by first comprehending what is being prescribed, and then regimenting one's daily routine to execute it. Education certainly helps comprehension; and it may assist regimentation by teaching patients how to allocate time during the day. Second, most medical recommendations require independent judgment and some accommodation by the patient. In Type 1 diabetes, a patient needs to consistently monitor their levels of blood glucose and titrate their insulin intake accordingly. The risk of acute hypoglycemia—and its attendant symptoms—must be balanced against the less immediate reduction in risk of long-term complications. Similarly, diabetics must learn how their body responds to insulin in many situations, and adjust their future regimens accordingly. For HIV, drugs must be timed with eating, fat content of meals, and fluid intake. Immediate side effects such as diarrhea, fatigue, nausea and vomiting must be balanced against longer-term mortality improvements.

Education could train people to be better at making these judgments, by making them better at obtaining and processing information like fat content.

On a positive note, our results suggest differential health outcomes across SES level due to different abilities to self-manage a demanding behavioral regimen are amenable. Our HRS results demonstrate that the presence of a wife can assist in maintaining adherence behavior. Second, our results from the DCCT indicate that imposing an enforced regimen combined with intensive patient monitoring—e.g., weekly phone reminders—eliminates the more negative health outcomes of the less educated. As Fink [(24)] notes, there is no universal treatment regimen for a standard patient. Our results do not imply prescribing less effective—but less complicated—therapy to the less educated. Rather, providers must assess the ability and willingness of a patient to comply with proscribed treatment, and manage treatment accordingly. Less educated patients would benefit more from frequent follow-up, simpler drug regimens, and clear instructions about how to comply and the consequences of non-compliance. Medical practice acknowledges that not all patients are alike in the nature of their disease. But neither are they the same in their ability to self-manage their treatment regimens unassisted.

Technology also plays a critical role in explaining health disparities. If medical science continues to evolve effective but complicated drug regimens, this may exacerbate health outcome disparities across patients with different levels of education unless we recognize that not all patients are equally adept at adherence. Research to encourage patients with low SES to better adhere to currently available treatments might be effective in improving the health of the millions of Americans with chronic disease. In the case of diabetes, research into better insulin-delivery devices might benefit only some patients, while other potential treatments such as stem cell transplantation might reduce disparities.

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Table 1
Educational Differences in HIV-related Treatment and Outcomes

Years of Schooling	Using HAART (%)	Using HAART And Adhering (%)	Fair or Poor General Health (%)	Change in CD4 Cell Count (cells per mm^3)
0-11	54.2	37.1	31.4	30
12	57.6	44.0**	25.4*	52
13-15	61.0**	45.2**	21.1***	54*
16+	68.4***	57.3***	17.8***	58**

***p<.01, **p<.05, *p<.10 for a test of equality with the 0-11 years of education subgroup.

Note: The first two columns show percentages using HAART and adhering to HAART at second follow-up in HCSUS. The third column shows the fraction at second follow-up reporting fair or poor general health, and the fourth column shows the change in CD4 cell counts from baseline to second follow-up.

Table 2

Predictors of Adherence to HIV Treatment and Subsequent Changes in Health

	Adhering to HAART treatment:			Change in general health:		
	β	Std. Error	p	β	Std. Error	p
Using HAART	——			0.126	0.064	0.048
Using HAART and adhering	——			-0.191	0.064	0.003
Education (excluded=0-11 years):						
12 years	0.041	0.102	0.690	0.028	0.072	0.691
13-15 years	0.183	0.102	0.073	-0.035	0.073	0.633
16+ years	0.308	0.122	0.012	-0.088	0.086	0.305
Black	-0.332	0.087	0.000	-0.018	0.061	0.770
Female	-0.182	0.102	0.074	0.196	0.071	0.006

Note: Models also control for age, exposure route, census region of residence, CD4 count at baseline, self-reported general health at baseline, and insurance status; full results are shown in the Appendix. The first three columns show probit regression estimates for adhering to HAART (among HAART users only). The second three columns show coefficient estimates from an ordered probit for whether general health improved, stayed the same, or got worse between baseline and second follow-up. Positive estimates in the ordered probit for change in health status indicate greater likelihood of condition worsening.

Table 3
Self- Assessed Health Status for All HRS Respondents and Those with Diabetes at Baseline

A. All Respondents

	Years of Schooling			
Baseline Health Status	0-11	12	13-15	16+
Excellent	12.0	23.2	29.5	39.2
Very good	20.7	32.8	34.7	35.4
Good	31.4	27.0	25.1	20.1
Fair	22.2	12.0	8.4	3.8
Poor	13.7	5.1	2.4	1.7
B. Respondents with Diabetes				
Excellent	2.5	3.7	10.2	8.2
Very good	12.1	14.1	18.6	30.0
Good	19.2	37.4	40.8	41.9
Fair	38.5	29.2	23.0	14.7
Poor	27.7	15.4	7.4	5.2

Note: Sample-Health and Retirement Survey. 51-61 years old in 1992.

Table 4
Patterns of Treatment Among Diabetics

Education	Always	Never	Switches
A. Take Oral Medication			
0-11	32.4	19.6	48.0
12	30.6	30.9	38.4
13-15	26.6	36.2	37.1
16+	40.7	36.0	23.3
B. Use Insulin or Pump			
0-11	21.4	56.1	22.5
12	20.5	57.2	22.3
13-15	15.4	63.5	21.1
16+	19.4	65.1	15.5

Note: Sample is respondents with diabetes at baseline in the Health and Retirement Study and 51-61 years old in 1992 (N=869). Rows sum to 100%. Patients with less education are more likely to switch treatment regimens over the course of the study.

Table 5
Predictors of a Change in General Health Status Between Wave 1 and Wave 4

	Change in General Health:		
	β	Std. Error	p
Years of Schooling (excluded=0-11 years):			
12 years	-0.164	0.101	0.105
13-15 years	-0.248	0.127	0.051
16 or more years	-0.199	0.142	0.160
Poor Self-Maintenance Behavior	0.246	0.102	0.016
Female	-0.099	0.084	0.240
Black	0.229	0.095	0.016
Hispanic	0.357	0.131	0.006

Notes: Model also controls for general health at baseline and birth year; full model results are shown in the Appendix. Sample is respondents with diabetes at baseline in the Health and Retirement Study and 51-61 years old in 1992 (n=869). Treatment regimens classified as 'poor' are associated with decrements in general health between Waves 1 and 4. Changes are estimated using an ordered probit (got worse, stayed the same, got better), so positive coefficient estimates indicate greater likelihood of worsening general health between waves.

Table 6
Predictors of Poor Self-Maintenance Behavior

	Without WAIS score:			With WAIS score:		
	β	Std. Error	p	β	Std. Error	p
Years of Schooling (excluded=0-11 years):						
12 years	-0.240	0.121	0.047	-0.151	0.124	0.224
13-15 years	-0.284	0.152	0.061	-0.142	0.160	0.373
16 or more years	-0.303	0.168	0.072	-0.065	0.185	0.724
Female	0.083	0.109	0.442	0.094	0.109	0.388
Black	0.110	0.115	0.338	0.011	0.120	0.927
Hispanic	0.013	0.158	0.933	-0.045	0.159	0.780
Married Waves 1 and 4	-0.078	0.12	0.517	-0.076	0.120	0.526
Married Wave 1 and Not Married Wave 4	0.492	0.304	0.106	0.546	0.305	0.073
Not Married Wave 1 and Married Wave 4	0.071	0.426	0.868	0.083	0.437	0.849
Female, Married Wave 1 & Not Married Wave 4	-0.580	0.378	0.126	-0.601	0.378	0.112
WAIS Score	----			-0.057	0.020	0.004

Note: Models also control for birth cohort and missing WAIS score; full results are shown in the Appendix. Sample is respondents with diabetes at baseline in the Health and Retirement Study and 51-61 years old in 1992 (n=869). Table shows results from a probit regression of whether the patient had a 'poor' treatment regimen over successive waves.

Table 7
Educational Differences in Treatment Adherence (at DCCT baseline)

Measure of adherence	Postgrad degree	College grad/ Some college	HS degree/ some secondary
No. of times self-monitored blood glucose per week	8.8	7.7	6.7
Missed insulin injection at least once in past month (%)	4.3	6.0	9.2
Did not follow insulin regimen at least once in past month (%)	15.7	25.2	26.6
Did not self-test blood or urine at least one day in past month (%)	66.1	74.1	77.2
Minutes of very hard exercise per week	58.1	49.6	19.7
Currently smoking cigarettes (%)	16.5	19.2	40.8

Note: Sample is non-student Type 1 diabetics from the DCCT (n=985). Adherence measures are from self-reports at baseline.

Table 8
Educational Differences in Treatment Impact for Diabetics

Group	Glycosolated Hemoglobin: Postgraduate Degree	College grad/ Some college	HS degree/ Some secondary
Conventional Therapy Only (n=495)			
Baseline	8.42	8.76	8.96
End-of-study	8.88	9.08	9.59
Difference	0.46	0.32	0.63
Intensive Treatment Only (n=490)			
Baseline	8.04	8.86	8.93
End-of-study	7.18	7.30	7.43
Difference	-0.85	-1.56	1.51
Treatment Effect[#]	-1.31	-1.88*	2.14**

*p<.10; **p<.05

#Treatment effect is the improvement in glycemic control among the intensive treatment group relative to conventional therapy. Average follow-up period was 72 months. Significance levels are for a test of equivalence with the postgraduate category and control for duration in study, gender, marital status, and age. Intensive treatment was more efficacious for the less educated.

APPENDIX

Full Model Results for Table 2

(HIV Treatment at Wave 1 and Change in General Health from Wave 1 to Wave 3)

	Adhering to HAART treatment:			Change in general health:		
	b	Std. Error	p	b	Std. Error	p
Using HAART	——			0.126	0.064	0.048
Using HAART and adhering	——			-0.191	0.064	0.003
Education (excluded=0-11 years):						
12 years	0.041	0.102	0.690	0.028	0.072	0.691
13-15 years	0.183	0.102	0.073	-0.035	0.073	0.633
16+ years	0.308	0.122	0.012	-0.088	0.086	0.305
Age	-0.021	0.032	0.508	0.045	0.020	0.026
Age squared	0.431	0.377	0.254	-0.442	0.238	0.063
Black	-0.332	0.087	0.000	-0.018	0.061	0.770
Female	-0.182	0.102	0.074	0.196	0.071	0.006
Used intravenous drugs	0.200	0.116	0.086	0.135	0.082	0.098
Male who has had sex with men	0.091	0.096	0.345	0.096	0.069	0.166
Census region (excluded=West):						
Northeast	0.298	0.108	0.006	-0.179	0.077	0.020
South	0.343	0.095	0.000	-0.142	0.066	0.032
Midwest	0.200	0.117	0.087	-0.032	0.089	0.723
Baseline CD4 count (excluded<50):						
500+	-0.383	0.201	0.056	0.021	0.109	0.850
200-499	-0.239	0.094	0.011	-0.152	0.071	0.031
50-199	-0.095	0.090	0.291	-0.064	0.069	0.358
Baseline health (excluded=Poor):						
Excellent/Very Good	0.294	0.139	0.034	2.063	0.113	0.000
Good	0.200	0.140	0.154	1.100	0.113	0.000
Fair	0.022	0.139	0.876	0.663	0.112	0.000
Insurance (excluded=none):						
Medicaid	0.009	0.123	0.942	0.280	0.083	0.001
Medicare	0.139	0.151	0.357	0.301	0.108	0.005
Private Insurance	0.002	0.126	0.985	0.134	0.086	0.118
Medicaid and Medicare	0.099	0.133	0.454	0.195	0.093	0.035
Income						
2^{nd} Quartile	0.021	0.115	0.855	0.084	0.077	0.273
3^{rd} Quartile	-0.017	0.114	0.880	-0.067	0.080	0.400
4^{th} Quartile	0.077	0.138	0.579	-0.141	0.096	0.142

Notes: See Table 2.

APPENDIX (con't)
Full Model Results for Table 5
(Change in General Health Status Between Wave 1 and Wave 4)

	Change in General Health:		
	β	Std. Error	p
Years of Schooling (excluded=0-11 years):			
12 years	-0.164	0.101	0.105
13-15 years	-0.248	0.127	0.051
16 or more years	-0.199	0.142	0.160
Wave 1 Respondent Health (excluded=Good):			
Excellent	1.665	0.323	<.001
Very Good	0.756	0.135	<.001
Fair	-0.633	0.104	<.001
Poor	-1.474	0.128	<.001
Poor Self-Maintenance Behavior	0.246	0.102	0.016
Birth year (excluded=before 1935):			
1935-1937	-0.131	0.107	0.222
1938+	0.141	0.094	0.134
Female	-0.099	0.084	0.240
Black	0.229	0.095	0.016
Hispanic	0.357	0.131	0.006

Notes: See Table 5.

APPENDIX (con't)
Full Model Results for Table 6
(Poor Self-Maintenance Behavior)

	Without WAIS score:			With WAIS score:		
	β	Std. Error	p	β	Std. Error	p
Intercept	-0.774	0.156	<.0001	-0.558	0.178	<.0001
Years of Schooling (excluded=0-11 years):						
12 years	-0.240	0.121	0.047	-0.151	0.124	0.224
13-15 years	-0.284	0.152	0.061	-0.142	0.160	0.373
16 or more years	-0.303	0.168	0.072	-0.065	0.185	0.724
Birth year (excluded=before 1935):						
1935-1937	0.213	0.128	0.096	0.231	0.129	0.073
1938+	0.101	0.116	0.384	0.122	0.117	0.294
Female	0.083	0.109	0.442	0.094	0.109	0.388
Black	0.110	0.115	0.338	0.011	0.120	0.927
Hispanic	0.013	0.158	0.933	-0.045	0.159	0.780
Marital Status:						
Married Waves 1 and 4	-0.078	0.12	0.517	-0.076	0.120	0.526
Married Wave 1 and Not Married Wave 4	0.492	0.304	0.106	0.546	0.305	0.073
Not Married Wave 1 and Married Wave 4	0.071	0.426	0.868	0.083	0.437	0.849
Female & Married Wave 1 & Not Married Wave 4	-0.580	0.378	0.126	-0.601	0.378	0.112
Proxy Respondent	-0.267	0.313	0.394	-0.241	0.310	0.438
WAIS Score	----			-0.057	0.020	0.004
WAIS Score missing	----			0.258	0.172	0.135

Note: See Table 6.