ORIGINAL ARTICLES

Physician Specialization and Antiretroviral Therapy for HIV

Adoption and Use in a National Probability Sample of Persons Infected with HIV

Bruce E. Landon, MD, MBA, Ira B. Wilson, MD, MSc, Susan E. Cohn, MD, MPH, Carl J. Fichtenbaum, MD, Mitchell D. Wong, MD, PhD, Neil S. Wenger, MD, Samuel A. Bozzette, MD, PhD, Martin F. Shapiro, MD, PhD, Paul D. Cleary, PhD

BACKGROUND: Since the introduction of the first protease inhibitor in January 1996, there has been a dramatic change in the treatment of persons infected with HIV. The changing nature of HIV care has important implications for the types of physicians that can best care for patients with HIV infection.

OBJECTIVE: To assess the association of specialty training and experience in the care of HIV disease with the adoption and use of highly active antiretroviral (ARV) therapy (HAART).

DESIGN: Observational cohort study of patients under care for HIV infection and their physicians.

PATIENTS AND SETTING: This analysis used data collected from a national probability sample of noninstitutionalized persons with HIV infection participating in the HIV Costs and Service Utilization Study and their primary physicians. We analyzed 1,820 patients being cared for by 374 physicians.

MEASUREMENTS: Rates of HAART use at 12 months and 18 months after the approval of the first protease inhibitor.

RESULTS: Forty percent of the physicians were formally trained in infectious diseases (ID), 38% were general medicine physicians with self-reported expertise in the care of HIV, and 22% were general medicine physicians without self-reported

expertise in the care of HIV. The majority of physicians (69%) reported a current HIV caseload of 50 patients or more. In multivariable models controlling for patient characteristics, there were no differences between generalist experts and ID physicians in rates of HAART use in December 1996. When compared to ID physicians, however, patients being treated by non-expert general medicine physicians were less likely to be on HAART (odds ratio [OR], 0.32; 95% confidence interval [95% CI], 0.17 to 0.61). Patients being treated by low-volume physicians were also much less likely to be on HAART therapy than those treated by high-volume physicians (OR, 0.26; 95% CI, 0.14 to 0.48). These findings were attenuated by June 1997, suggesting that over time, the broader physician community successfully adopted HAART therapy. This finding is consistent with prior research on the diffusion of innovations.

CONCLUSIONS: Similar proportions of patients treated by expert generalists and ID specialists were on appropriate HAART therapy by December 1996 and July 1997. Patients treated by non-expert generalists, most of whom were the lowest-volume physicians, were much less likely to be on appropriate ARV therapy in the earlier time period. Our findings demonstrate that generalists who develop specialized expertise are able to provide care of quality comparable to that of specialists.

KEY WORDS: HIV; AIDS; specialism; physicians' practice patterns; HAART therapy.

J GEN INTERN MED 2003;18:233-241.

Received from the Division of General Medicine, Beth Israel Deaconess Medical Center (BEL) and the Department of Health Care Policy (BEL, PDC), Harvard Medical School, Boston, Mass; the Division of Clinical Care Research and the Department of Medicine, New England Medical Center (IBW), Boston, Mass; RAND Health (SAB, MFS), Santa Monica, Calif; the Veterans Affairs San Diego Healthcare System (SAB), San Diego, Calif; the University of California at San Diego (SAB), La Jolla, Calif; the University of California at Los Angeles (MDW, NSW, MFS), Los Angeles, Calif; the University of Rochester Medical Center (SEC), Rochester, NY; and The University of Cincinnati College of Medicine (CJF), Cincinnati, Ohio.

Presented in part at the 25th annual meeting of the Society of General Internal Medicine, May, 2002, Atlanta, Ga.

Address correspondence and requests for reprints to Dr. Landon: Department of Health Care Policy, Harvard Medical School, 180 Longwood Ave., Boston, MA 02115 (e-mail: landon@hcp.med.harvard.edu).

Since the introduction of protease inhibitors in January 1996, there has been a dramatic change in the treatment of persons infected with HIV.¹⁻³ Numerous clinical trials have demonstrated the effectiveness of multi-drug regimens for treatment of HIV, and national guidelines for the treatment of HIV infection released since 1996 support their use.²⁻⁵ Since that time, AIDS morbidity and mortality in the United States have fallen dramatically.^{6,7} Potent combination chemotherapy for HIV requires detailed knowledge of multiple side effects and drug interactions and requires frequent monitoring and adjustments to achieve maximal benefit.³ Drug therapy for HIV has become the single largest component of medical costs for patients with HIV.⁸

Changes in HIV care have important implications for the types of physicians that can best care for patients with HIV infection. Even before the use of protease inhibitors, data from a sample comprised mostly of family practitioners suggested that at least some experience in treating HIV was associated with improved survival.⁹ A more recent study using case vignettes found that both training in infectious diseases (ID) and HIV experience were associated with the use of appropriate antiretroviral (ARV) regimens and that, controlling for experience, ID physicians were more likely to choose appropriate ARV regimens. These findings, however, were attenuated after excluding physicians who do not manage HIV infection by themselves.¹⁰ Another recent study demonstrated that providers with higher HIV caseloads were earlier adopters of complex antiretroviral regimens.¹¹ Current guidelines recommend that these complex antiretroviral medications be prescribed only by physicians with "extensive experience."³ No study in the current era of highly active antiretroviral therapy (HAART), however, has examined actual prescribing behavior and its relationship to provider characteristics such as experience and formal training.

The HIV Costs and Services Utilization Study (HCSUS), a study of a nationally representative sample of persons receiving care for HIV, provides a unique opportunity to study the introduction and adoption of a new therapy for the treatment of a chronic medical condition by physicians, because HCSUS began collecting data just as protease inhibitors were first licensed.^{1,12} In this study, we examine the relationship between physician specialty and subspecialty training, experience with HIV as defined by their volume of HIV patients, self-rated HIV expertise, and objective HIV knowledge and adoption and use of HAART therapy in this large nationally representative sample of persons with HIV infection.

METHODS

Participants and Data Collection

Patient Sample. The HIV Cost and Services Utilization Study used a multistage probability sample of persons in care for HIV in the contiguous United States.¹²⁻¹⁴ In the first stage of sampling, we randomly selected metropolitan statistical areas and clusters of rural counties that, in the aggregate, contained nearly 70 percent of all U.S. cases of AIDS.^{15,16} In the second stage, we randomly selected providers (typically institutions) who had been identified by local physicians or public health officials as caring for patients with HIV infection, as well as other providers who had reported caring for patients with HIV infection during a screening survey of approximately 4,000 randomly selected physicians. In the third stage, patients seen by sampled providers were randomly sampled during January and February 1996. The study enrolled 2,864 patients and these patients completed a baseline interview and 2 subsequent interviews about aspects of their care, including costs, access to care, and antiretroviral use.^{1,2,17}

Physician Sample. As part of the second patient interview (conducted in the first half of 1997) subjects were asked to identify all of their providers, including the physician most important for their HIV care. Eighty-five percent of patients were able to identify such a physician. In cases in which the patient was unable to identify a principal HIV physician, we created an algorithm to match the patient with the physician most likely to be responsible for his/her care. First, we selected the physician the patient said he or she saw most recently for HIV care and if there was no such physician, then we selected a non-HIV primary care physician that they identified. We repeated this process using the baseline survey if no physician had been identified in the follow-up survey. We were able to identify a physician for 2,642 patients (92% of the sample).¹⁸

Physician Data Collection. We confirmed physician mailing addresses and names for 551/692 identified physicians (80%) by telephoning their practice site or local contacts, checking the AMA website, and conducting Internet searches to obtain addresses.^{18,19} We sent these 551 physicians a survey with a \$25 check as a token of appreciation for study participation. Nonrespondents received 3 follow-up calls and were offered the chance to complete the survey by phone. The surveys were administered between September 1998 and July 1999.

Of the 551 clinicians contacted, 412 (75%) completed the survey (60% of the 692 identified clinicians). Thirty-three of these were nurses, nurse practitioners, or physician's assistants (including 1 with incomplete specialty data) whom 76 HCSUS participants had incorrectly identified as physicians; we eliminated these. In addition, the patients that identified 5 of the physicians were subsequently deemed to be ineligible because they were cared for at multiple sampling sites, thus leaving a total of 374 useable physician responses.

Analytic Variables

Outcome Variables. Our working definition of HAART use, which is based on the Department of Health and Human Services/Henry J. Kaiser Foundation *Guidelines for the Use of Antiretroviral Agents in HIV-infected Adults and Adolescents* was "taking certain combinations of nucleoside reverse transcriptase inhibitors (e.g., zidovudine and lamivudine) plus certain protease inhibitors ([PIs], e.g., nelfinavir), combinations of PIs (e.g., ritonavir and saquinavir), or the combination of a PI plus a non-nucleoside reverse transcriptase inhibitor (e.g., nevirapine)."²⁰ Each patient was classified as taking HAART if he/she reported taking any 1 of the HAART combinations. According to guidelines published close to the time of the baseline interview,^{2,21} 99% of the sample were eligible for HAART because they had either CD4 <500 cells/mm³ or HIV RNA >10,000 copies per mL, or they had symptomatic HIV or AIDS. While these guidelines have subsequently been

modified, that should not affect our findings related to the primary questions under study.

We focused on the use of HAART by December 1996 and June 1997 to capture the diffusion of HAART therapy after its introduction in December 1995. In addition, this time period corresponds to the time when the patients identified their physicians. The HAART by December 1996 variable was constructed from both the baseline and follow-up surveys, while the HAART by June 1997 also included data from the second follow-up survey. In each round of interviews, patients were asked to report whether they had taken specific antiretroviral medications and at what point they started taking them. These data were used to create a dichotomous variable indicating HAART use as described in Anderson et al.²²

Predictor Variables. *Data on physician specialization.* For these analyses, we used selected physician characteristics: physician training and specialization, experience treating HIV, self-rated expertise, and knowledge of HIV practices.¹⁸ Physicians were classified as being trained in either infectious diseases or general medicine/other for the purposes of this analysis. The survey also asked about the physicians' current and past HIV practice experience, including the number of patients currently cared for (categorized based on our previous analyses as low [0 to 19], medium [20 to 49], and high [>49]), the cumulative number of patients cared for in the previous 5 years, and the proportions with various risk behaviors for acquisition of HIV in their patient population. We created variables indicating whether the physician said that 50% or more of his or her patients had intravenous drug use, male-to-male sex, or male-to-female sex as a risk behavior for HIV acquisition. The physicians were also asked whether they considered themselves "specialists" (hereafter referred to as "experts") in the treatment of HIV.

Only 6 of 152 (4%) of ID physicians in the sample did not consider themselves HIV experts. To examine the joint effects of training and expertise in multivariable models, we therefore created a composite training/expertise variable with 3 levels: ID physicians, generalist experts, and generalist non-experts. Because current and cumulative caseloads were highly correlated ($r = .58$), we used only current caseload in these analyses.

Physician knowledge. The physician survey also included a series of questions that asked about the physicians' knowledge of current HIV treatment practices, including questions related to prophylaxis against opportunistic infections and screening (5 questions), and viral load testing and antiretroviral therapy (6 questions). The number of correct responses out of 11 were summed to form a knowledge score. "Don't know" responses were classified as incorrect. The Cronbach's α for the resulting scale was 0.64.¹⁸ Because of the skewed distribution of the score, we also created a dichotomous variable ("high" HIV knowledge) indicating whether the physician was correct on 80% or more of these questions.

Patient control variables. Additional information relating to sociodemographic and clinical characteristics, including age, gender, education, income, insurance status, mode of acquisition of HIV, and lowest ever CD4 count were included as control variables in all analyses.^{1,23} We imputed missing values for essential patient control variables using standard "hot deck" imputation for less than 5% of CD4+ lymphocyte counts, less than 3% of insurance and income values, and less than 0.5% of other missing values.^{13,17} Finally, because patient attitudes are related to the use of antiretroviral medications, patients who do not want to take ARVs might be more likely to choose non-expert generalist physicians. We therefore included a question from the baseline survey that measured patients' attitudes toward antiretroviral therapy. Patients were asked if, after considering the benefits and risks of ARVs, they thought that these medications were definitely or probably worth taking, probably not worth taking, or definitely not worth taking. For multivariable models, these responses were dichotomized to definitely or probably worth taking versus not worth taking. For 39 respondents missing this information from the baseline survey, we used their response on the follow-up survey.

Analyses

Missing Data and Weighting. We compared the demographic characteristics of patients who could not identify a physician and of patients whose physician did not respond to the survey with those of patients whose physician did respond to the survey. All analyses are weighted to reflect the national noninstitutionalized population under care for HIV infection.¹³ In addition, we also applied a weight to account for physician nonresponse. All analyses were performed using SUDAAN software, Version 8 (Research Triangle Institute, Research Triangle Park, NC) to account for the effects of the complex sample design and clustering of patients within physicians.

Bivariate and Multivariate Relationships. We examined bivariate relationships between ID training, HIV caseload, self-assessed expertise, and the composite training/expertise variable and the use of HAART therapy with χ^2 tests or t tests, as appropriate. We estimated a series of multivariable logistic regression models for the main outcomes of interest. We first constructed a baseline model that controlled for patient-level effects.²² We then estimated separate models that examined the individual effects of specialty training, the joint composite training/expertise variable, and current HIV caseload in models that only controlled for patient-level effects. The final model examined the joint effects of these variables together as well as HIV knowledge.

Sensitivity Analysis. A 2-part propensity score analysis was also conducted to test for the possibility that some of the

differences among physicians were due to the fact that certain types of patients were more likely to be treated by specialized or experienced physicians.²⁴ For the first model, the probability of seeing a general physician (as opposed to an ID physician) was modeled, and for the second model, the probability of seeing a general medicine expert (as opposed to a non-expert) was modeled. Both models used the patient-level predictors from the HCSUS surveys, primarily related to sociodemographic factors, CD4 count, and risk factors. Weights were developed to create balanced samples, and the regressions were repeated using a combination of these weights and the sampling weights mentioned above. Because these analyses were not substantively different from those that did not incorporate these adjustments, we present the models that did not incorporate these weights.

Role of the Funding Sources. The funding sources had no role in the collection, analysis, or interpretation of the data or in the decision to submit the manuscript for publication.

RESULTS

A total of 374 physician responses were linked to 1,820 (64%) of the 2,864 persons enrolled in HCSUS. Of the 1,044 patients that were not linked to a physician, 222 did not identify any specific physician as responsible for their care in either the baseline or follow-up surveys, and 76 identified a nurse, nurse practitioner or physician's assistant. Therefore, the number of patients who were either linked to a physician or did not identify any physician is 2,042 (1,820 plus 222), accounting for 71% of the HCSUS cohort.

Physician Characteristics

Forty percent of the physicians were formally trained in infectious diseases (representing physicians caring for 46.5% of HIV cases under care), 38% were general medicine physicians with expertise in the care of HIV (representing 44.5% of patients under care), and 22.2% were general medicine physicians without expertise in the care of HIV (representing 9.1% of patients) (Table 1). The majority of physicians (69%) reported a current HIV caseload of 50 patients or more. No information was available on nonresponding physicians.

Patient Characteristics

Table 2 presents a description of the patient sample by the main types of physicians. Seventy-eight percent of the patients were men and approximately 32% were African American. Twenty-three percent had intravenous drug use as their primary risk factor for HIV acquisition, while 49% said that they were males who had sex with males. A comparison of the demographic characteristics of patients who were included and excluded from the study sample revealed no significant difference (data not shown).

Table 1. Provider Characteristics

Provider Characteristics	Unweighted	Weighted to Patients Cared for Nationally and MD Nonresponse
Years of practice, mean (SD)	16.5 (7.8)	19.0 (6.7)
Male, %	72.2	81.6
Race, %		
White	78.6	70.7
African American	7.0	5.1
Other	14.4	24.2
Training, %		
General medicine expert	38.0	44.5
General medicine non-expert	22.2	9.1
ID specialist	39.8	46.5
HIV case load, %		
0–19 patients	19.8	8.8
20–49 patients	11.2	4.5
≥50 patients	69.0	86.7
HIV patient population risk factors, %, majority of cases with		
IV drug use as a risk factor	16.3	18.6
Male sex as a risk factor	66.3	56.9
Heterosexual contact as a risk factor	13.6	17.2

ID, infectious diseases; IV, intravenous.

Patients being seen by general medicine experts were more likely to have no insurance (21.6% for general medicine experts as compared to 10.6% for non-experts and 7.7% for ID physicians). In addition, patients of general medicine experts had lower income (22.7% with annual income <\$5,000 versus 11.5% and 17.7% for general medicine non-experts and ID physicians, respectively) and less-advanced HIV disease (22.5% with a lowest CD4 count <50 cells/mm³ as compared to 27.6% and 28.5% of patients being cared for by general medicine non-experts and ID physicians, respectively). Finally, a higher proportion of patients being treated by general medicine non-experts felt that ARVs were probably or definitely not worth it (31.5% versus 18% for general medicine experts and 15.9% for ID physicians; $P < .01$ for both comparisons).

Use of and Adoption of HAART Therapy

Bivariate Relationships. Overall, 39.5% of the population were taking HAART therapy by December 1996. This proportion increased to 65.8% by June 1997 (Table 3). Patients being cared for by ID physicians were more likely to be on HAART therapy than those being cared for by non-expert general medicine physicians at both time periods (44.1% vs 32.9% by 12/96 and 70.5% vs 59.7% by 7/97).

Table 2. Patient Characteristics by Type of Physician*

Patient Characteristics	Study Patients (N = 1,820)	ID Physicians (N = 793)	General Medicine Experts (N = 878)	General Medicine Non-experts (N = 149)
Age (SD)	39.2 (8.6)	39.4 (8.3)	39.1 (9.0)	39.1 (8.4)
Gender, %			+	
Male	77.6	72.9	81.2	84.2
Female	22.4	27.1	18.8	15.6
Race, %			+	
White	50.1	50.6	47.8	58.7
African American	31.8	28.2	36.0	30.0
Hispanic	15.2	19.3	12.6	7.0
Other	2.9	1.9	3.6	4.2
Education, %				
Less than high school	24.3	23.4	27.1	15.2
High school graduate	28.0	30.3	25.6	27.8
Some college	28.0	27.6	27.8	30.7
College graduate	19.7	18.7	19.5	26.3
Insurance, %				
No insurance	14.1	7.7	21.6	10.6
Medicaid	28.7	32.0	26.4	23.2
Medicare	23.7	25.7	21.6	24.1
Private	33.5	34.7	30.4	42.1
Income, %				
<\$5,000	19.3	17.7	22.7	11.5
\$5–\$10k	25.7	25.6	26.0	24.3
\$10k–\$25k	26.1	26.3	26.3	24.1
<\$25k	28.9	30.5	25.0	40.1
Lowest CD4 counts, %				
≥500 Cells/mm ³	8.2	8.6	7.2	11.0
200–499 Cells/mm ³	36.3	32.7	40.7	33.4
50–199 Cells/mm ³	29.8	30.2	29.7	28.0
<50 Cells/mm ³	25.8	28.5	22.5	27.6
Risk, %				++
IVDA	23.3	28.8	18.4	19.0
Man sex with man	49.0	41.7	53.5	64.0
Heterosexual contact	18.6	21.0	18.4	7.6
Other transmission	9.1	8.6	9.6	9.3
Attitude toward taking antiretrovirals (N = 1,811), %				++**
Definitely worth it	49.0	51.2	47.1	47.3
Probably worth it	32.8	32.9	34.9	21.3
Probably not worth it	8.4	7.1	8.7	13.3
Definitely not worth it	9.9	8.8	9.3	18.2

* The percentages for each categorical variable may not add up to 100% due to rounding.

(++) or (+) indicates significant level between column 2 and column 3 /column 4 at .01 and .05, respectively.

(**) indicates significant level between column 3 and column 4 at .01 and .05, respectively.

These data are weighted to reflect the national sample of patients under care for HIV and physician nonresponse.

ID, infectious diseases; IVDA, intravenous drug abuse.

$P < .05$). The rate for patients being cared for by general medicine experts fell between the rates observed for ID physicians and general medicine non-experts, although the rates were closer to those of general medicine non-experts.

Multivariable Relationships. In multivariable models that examined HAART use by December 1996 after controlling for patient characteristics, patients being treated by general medicine physicians (Fig. 1, model 1) were far less likely than patients of ID physicians to have been on HAART (odds ratio [OR], 0.69; 95% confidence interval [95% CI], 0.52 to 0.95). After classifying generalist physicians according to their self-rated expertise, how-

ever, only patients being treated by non-expert general medicine physicians were less likely to be on HAART (OR, 0.32; 95% CI, 0.17 to 0.61) when compared to ID physicians (Fig. 1, model 2). There was no significant difference between general medicine experts and ID physicians (OR, 0.80; 95% CI, 0.59 to 1.10). In models that examine physician HIV caseload, patients being treated by low-volume physicians were also much less likely to be on HAART therapy (OR, 0.26; 95% CI, 0.14 to 0.48) than those treated by high-volume physicians (Fig. 1, model 3). In models including both the training/expertise variables and patient caseload, because of the close relationship between these 2 variables, only patients

Table 3. Bivariate Relationship Between Predictors and Outcome Variables

Physician Characteristics	On HAART by December 1996, %	On HAART by June 1997+, %
Overall sample	39.5	65.8
Medical training	*	*
General medicine–non-expert	32.9	59.7
General medicine–expert	36.5	62.6
Infectious diseases	44.1	70.5
Self-designated HIV expert	*	*
Yes	40.6	67.0
No	29.4	55.3
Current case load	*	†
0–19 Patients	25.6	55.6
20–49 Patients	41.9	63.0
≥50 Patients	40.5	66.8
Knowledge, % correct		
<80%	39.7	67.5
≥80%	39.4	64.8

* Indicates significant at $P < .01$.

† Indicates significant level at $P < .05$.

with low-volume physicians with between 0 and 19 current HIV-infected patients had lower odds of being on HAART by December 1996 (data not shown). Although HIV knowledge is associated with both specialty/expertise and caseload, HIV knowledge was not an important predictor after controlling for the other physician characteristics.¹⁸

Predictors of HAART use by June 1997 were consistent with those seen in the December 1996 models, although the effects of specialty training and caseload were attenuated and no longer statistically significant. These findings suggest that over time, this innovation diffused successfully throughout the physician community.

DISCUSSION

One year after the introduction of the first protease inhibitor, 30% to 40% of eligible patients with HIV infection were taking HAART therapy. This number had risen to 60% to 70% just 6 months later. In this study, specialty training and expertise of the physicians caring for these patients were important predictors of early adoption and use of HAART. At both 1 year and 1½ years after the approval of the first protease inhibitor, we found that patients of non-expert generalist physicians had lower rates of HAART therapy than either patients of physicians with specialty training in ID or patients of generalists physicians with expertise in the care of HIV patients. These findings, however, were attenuated by June 1997 and no longer statistically significant, suggesting that over time, HAART therapy was successfully adopted by the broader physician community such that generalist physicians who lacked expertise in HIV care were also using this important therapy. These findings are consistent with the literature on the diffusion of innovation.²⁵

This is the first study that we are aware of to simultaneously examine the influence of formal training and expertise (including caseload) on the treatment patterns of a nationally representative population of patients with a chronic medical condition. These findings suggest that generalist physicians with appropriate experience have the potential to provide high-quality care to patients with complex chronic illnesses, at least as measured by the specific measure of technical quality that we examined in this study, and that their patients get similar access to important new therapeutic advances. Conversely, physicians with little experience should not be relied upon as the primary caregivers for complex conditions unless they are able to co-manage the patients with an expert provider. Consequently, guidelines and treatment algorithms should be designed to incorporate the possibility of differential levels of expertise among generalists (and specialists) and should acknowledge that generalist physicians are often able to provide high-quality care as well. While guidelines for the treatment of HIV infection have evolved over the last several years, we examined measures of HAART use that were thought to be state of the art during the time period of our study. Thus, these changes in recommendations would not affect our main conclusions with respect to physician specialization and the adoption and use of state-of-the-art treatments for a complex chronic medical condition.

In research conducted before the introduction of protease inhibitors, Kitahata et al. found that patients of physicians who had treated at least 5 HIV-infected patients had lower mortality.⁹ Findings from Stone et al., who also used a cutoff of 5 patients to define low-volume physicians, also indicated that experience in HIV care was beneficial, but other cutoffs were not reported.¹⁰ In our study, few physicians were caring for 5 or fewer patients. Our data suggest that as the AIDS epidemic has matured, physicians who care for HIV-infected patients tend to have a higher caseload. Thus, as the complexity of care has increased, HIV caseloads have increased, suggesting that physicians require a higher threshold of patients to maintain competence. Despite this, low-volume physicians continue to care for almost 10% of the population with HIV infection.

Some have hypothesized that patients who want to pursue the most advanced and aggressive therapy will preferentially seek out physicians trained in infectious diseases and/or the most-experienced clinicians. While patients of ID physicians did have slightly more advanced HIV disease, the vast majority of patients seen by each class of physicians rated taking antiretroviral therapy as “definitely or probably worth it.” Nonetheless, fewer patients of generalist non-experts agreed with this statement, so patient attitudes were adjusted for in our multi-variable analyses. Thus, while patient attitudes toward taking ARVs were important predictors of being on HAART therapy, differing attitudes did not account for differences in use of HAART therapy across types of physicians.

FIGURE 1. Multivariable predictors of HAART use. Results are presented as odds ratios with their associated 95% confidence intervals. Base model controls for the following patient-level variables: age, gender, education, income, insurance status, mode of acquisition of HIV, lowest ever CD4 count, and attitudes toward taking ARVs. $N = 1,811$ for the HAART by 12/96 models (9 respondents were missing information about attitudes toward ARVs). The 7/97 models include only patients still alive at June 1997 that had information on attitudes toward ARVs ($N = 1,630$). # ID is the omitted variable; † Caseload ≥ 50 is the omitted variable.

Studies of other conditions have shown that specialists are usually more knowledgeable than generalists about diagnostic techniques^{26,27} and efficacious therapies.^{28,29} In addition, specialists tended to provide care deemed appropriate at higher rates than generalists when processes of care are examined (using chart reviews or patients' reports) for acute myocardial infarction,^{30,31} unstable angina,³² asthma,³³ acute arthritis,^{34,35} multiple sclerosis,³⁶ and depression.³⁷ In addition, studies have demonstrated that high-volume physicians have better outcomes for treatment processes such as angioplasty and many surgical procedures.³⁸⁻⁴¹ Our findings extend these studies by examining formal training and caseload simultaneously and suggest that caseload, as a measure of expertise, might be as important or more important than specialty training. In addition, we also show that while specialized physicians adopt new treatment strategies more rapidly, these innovations successfully diffuse to the broader physician community over time. To the extent that a particular disease condition is experiencing rapid intro-

duction of new treatment modalities, however, expert clinicians (whether by virtue of specialty training or other modes of developing expertise) will generally provide more-current therapy to patients.

Our study has several limitations. First, although we were able to identify appropriate links to physicians for over 70% of the sample, there might have been unmeasured differences between linked and unlinked patients. Including patient characteristics and weights adjusting for nonresponse in our models, however, largely controlled for these potential biases. Furthermore, propensity score analysis results were consistent with our original findings. Second, while we carefully identified the physicians caring for the HCSUS patients, some patients may have switched physicians at some point in time. Consequently, we focused our analysis on the time period closest to the identification of the physicians. In addition, we would expect that any misclassifications would make it more difficult to detect true differences. Third, while this is among the largest studies to date of this type, small

differences can sometimes have a larger cumulative impact when they apply to large numbers of patients. Thus, we might have lacked power to detect important differences between ID physicians and general medicine experts. Finally, we only examined 1 important aspect of care for patients with HIV infection. We might have observed different results if we had examined other processes of care, such as the appropriate treatment of opportunistic infections.

Our findings demonstrate that expert generalists, whether by virtue of experience or interest, are able to provide care of quality equal to that of specialists, at least as measured by the use of HAART therapy. Guidelines and strategies to improve care for HIV patients should therefore promote the use of expert generalists as well as ID physicians. In addition, physicians without such expertise care for a small but substantial proportion of patients. Developing strategies to obtain appropriate expert input for these patients might also lead to improved outcomes.

We are indebted to Lin Ding, PhD for assistance with expert statistical programming; to Deborah Collins for assistance with manuscript preparation; to Shirley Nederend and Dana Perry for assistance with survey administration.

Supported by grants from the Robert Wood Johnson Foundation, the Agency for Healthcare Research and Quality (grant no. R-01HS10227), and the Aetna Quality Forum, and by a cooperative agreement (U-01HS08578) between RAND and the Agency for Health Care Policy and Research. Dr. Bozzette is a Health Services Research and Development Senior Research Associate of the Department of Veterans Affairs.

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