

Number of Primary Care Visits Associated with Screening for Cervical Dysplasia among Women with HIV Infection in Harris County, Texas, United States of America

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Abstract

Studies indicate that women with HIV infection in the United States are inadequately screened for cervical dysplasia. However, few of these studies have included women in the southern United States, where HIV incidence is now concentrated. We performed a retrospective chart review of women with HIV infection in two HIV clinics in a large southern metropolitan area. To describe screening rates among women in care, only women with ≥ 2 primary care clinic visits during 2007 were included. We used log-binomial regression to estimate prevalence ratios and 95% confidence intervals of screening and to identify demographic, behavioral, and care-related factors associated with screening. Only 52% (258/498) of women in our study were screened during the year and only 29% (8/28) of women with ≤ 50 CD4 cells/mm³. Factors associated with increased screening in unadjusted analyses included increased number of primary care visits ($p < 0.001$), higher CD4 cell count ($p < 0.001$), younger age ($p = 0.006$) and Hispanic compared to non-Hispanic ethnicity ($p < 0.001$). In adjusted analyses, women with ≥ 4 primary care visits were 21% more likely to be screened than women with < 4 visits (adjusted prevalence ratio = 1.21; 95% confidence interval: 1.02–1.44). Women with CD4 cell counts < 200 cells/mm³ were less likely to be

screened than women with CD4 counts ≥ 350 cells/mm³ (adjusted prevalence ratio: 0.77; 95% confidence interval: 0.59–1.00). Rates of screening for cervical dysplasia were lower than those seen in similar care settings in other geographic areas in the United States. The number of HIV primary care visits, which has been associated with retention in care, was associated with screening prevalence. Interventions designed to improve retention in care may improve screening rates for cervical dysplasia as well.

Keywords: Pap test, HIV in women, Cervical dysplasia, Retention in care, Adherence

Abbreviations: AIDS: Acquired Immunodeficiency Syndrome; APR: Adjusted Prevalence Ratio; CD4: Cluster of Differentiation 4; CDC: United States Centers for Disease Control and Prevention; CI: Confidence Interval; DHHS: United States Department of Health and Human Services; DSHS: Department of State Health Services; HIV: Human Immunodeficiency Virus; HAART: Highly Active Antiretroviral Therapy; HPV: Human Papilloma Virus; HRSA: Health Resources and Services Administration; IQR: Inter Quartile Range; RNA: Ribonucleic Acid; STD: Sexually Transmitted Disease; USA: United States of America; USPSTF: United States Preventive Service Task Force

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Introduction

Multiple investigators [1 - 5] have noted an increased risk of HPV-associated disease, including cervical dysplasia, among persons with HIV infection, even since the introduction of HAART, and cervical cancer remains among the AIDS-defining malignancies as a result of epidemiologic studies performed among USA women. Fortunately, screening can prevent sequelae of cervical dysplasia and progression from cervical dysplasia to cervical cancer, and, for this reason, DHHS [6] recommends that women with HIV infection be screened every 6 months the first year after HIV is diagnosed and annually thereafter. However, despite this recommendation, many women are not screened. Oster, Sullivan and Blair [7] showed that among 2,417 women surveyed from 18 states, 23% denied having been screened during the preceding year.

Numerous studies from around the world and from different geographic regions of the USA [7 - 17] have examined rates of screening for cervical dysplasia and factors associated with screening for cervical dysplasia among women with HIV infection. Screening rates have differed by geography and clinical setting. Furthermore, the studies examining screening rates have had heterogeneous periods of observation, making comparison among studies challenging. Three previous multicenter studies, two of which were nationally representative [7, 15] and one among Ryan White-supported facilities [18], included screening for cervical dysplasia among women with HIV infection living in the southern USA over study periods ranging from 10–12 months but did not stratify their results by geographic region. Screening rates in these studies ranged from 77–88%. Logan and colleagues [9] reported a rate of 83% during the first year in care among women receiving care from a Ryan White- supported facility in a single Florida county. In California, Rahangdale and associates [19] reported that 78% of

HIV-infected women in their public health clinic were screened at least once over a 4-year period. Lower rates, ranging from 47–78% during study periods ranging from 12–18 months, have been reported among urban HIV clinics affiliated with academic medical centers in northeastern USA cities, including Boston [8], Baltimore [10], and New Haven, Connecticut [12]. Keiser et al. [11] reported the lowest screening rate in the literature, 26% over three 15-month time periods, among a cohort of Swiss women.

Age, race/ethnicity, insurance status, educational level, CD4 count, previous abnormal screening results, and, in a few studies, number of primary care visits or retention in care have all been examined as potential predictors of screening. Overall, studies in differing geographic areas have elucidated different predictors of screening and have noted differences in the direction of the relationship as well.

Few studies examining cervical dysplasia screening among women with HIV infection have included women from the southern USA, who, according to the CDC [20], have the highest prevalence of HIV infection among USA women. El-Sadr, Mayer and Hodder [21] have reported that southern minority women have a greater risk for acquiring HIV than other women in the USA. Additionally, Meditz and associates [22] have reported that minorities and persons living in southern states are less likely to initiate HAART and that minorities living in the southern USA are more likely to experience HIV-related and AIDS-defining illnesses. Thus, studies must be conducted among women living in the southern USA to develop effective interventions for this vulnerable population.

Houston is the largest metropolitan area in Texas, and, in 2010, nearly one-third of persons living with HIV in Texas were diagnosed in the Houston eligible metropolitan area [23]. During 2007, according to the Texas DSHS HIV/STD Prevention and Care Branch [23], the HIV incidence rate in the Houston area was 13.4 per 100,000 among women, compared with 10.7 per 100,000 among females in the USA [20]. We

investigated the prevalence of screening for cervical dysplasia and factors associated with screening in this large urban area in Texas.

Materials

We studied women receiving care in two HIV care clinics in the Harris Health System, which serves Harris County and includes Houston [23]. The Harris Health System is the largest HIV care option in Harris County. Over 80% of patients are Hispanic or black and fewer than 10% have private insurance [24]. Both clinics receive Ryan White funding, which supports access to HIV care and social services for persons who could not otherwise afford them. Health system services are provided on a sliding scale, and a large proportion is charity care. During the study period, specialist gynecologic care was provided in each clinic weekly. Screening was performed by liquid cell cytology (SurePath™, Becton, Dickinson and Company, Burlington, North Carolina, USA). In one clinic, primary care providers were physicians trained in infectious diseases; in the other clinic, they were family practitioners. Of the 4,331 patients seen by the two clinics in 2007, 31.9% were women. Of the women seen in 2007, 71% were black and 20% were Hispanic. The mean age was 41.8 years, and the mean time since diagnosis of HIV infection was 7.7 years.

To identify women for this study, we used a convenience sample of 498 women from a list of medical record numbers of all HIV-infected women who received care in either clinic during 2007, which was the first year during which electronic medical records were used at these facilities. Women were included who were age 13 years or older, seen at either clinic for ≥ 2 primary care visits during January 1, 2007–December 31, 2007, and had documented HIV infection. We excluded pregnant women. This sample size is estimated to permit detection of a predictor with a 26% or larger effect on screening, assuming alpha of 0.05 and 80% power.

We defined being in care during 2007 as having two or more primary care visits, rather than urgent care visits, at either clinic

during 1 January–31 December 2007 to allow adequate opportunity for gynecologic care referral during that time period. Gynecologic specialists provided care and screening in the same facility. Patients were referred for care, which was provided either on the same day, if an appointment was available, or during a subsequent scheduled visit. The institutional review board for Baylor College of Medicine in Houston, TX, USA approved this study. The requirement for informed consent was waived.

Methods

Data Acquisition

A single investigator (NJDG) abstracted data from each of the electronic medical records during 2008–2009 using a standardized abstraction form. Ascertainment of a history of screening for cervical dysplasia during 2007 included a complete review of the medical record, including review of electronic laboratory records and all study period progress notes for any mention of outside screening. Women were classified as screened if they had any documentation of actual screening during 2007.

Using the abstraction form, we collected demographic characteristics, risk behaviors, characteristics of care delivery, characteristics of HIV disease, and gynecologic history. We recorded age on December 31, 2007, race/ethnicity, and zip code from the medical record. We also recorded HIV-related risk factors as documented in the medical record categorized as: heterosexual activity, intravenous drug use, other (blood transfusion or vertical transmission), and unknown. Tobacco use or alcohol abuse was recorded if either was documented to be active at any point during 2007. Characteristics of care delivery were recorded from the medical record and included clinic setting (specialty or family practice), number of primary care visits attended, number of providers seen during the year, and number of appointments missed during 2007. Only visits to one of the two study clinics were considered. Urgent care appointments were reviewed but not included, because such appointments were problem-focused and did not address preventive care. Characteristics of HIV disease, including year

of HIV diagnosis, lifetime nadir CD4 cell count, HAART prescription, and last recorded CD4 count and HIV RNA titer during 2007, were collected from the electronic medical record and laboratory results. AIDS was defined by nadir CD4 count <200, documented AIDS-defining illness, or AIDS diagnosed by the care provider. Gynecologic history included any documented history of abnormal screening for cervical dysplasia results, hysterectomy, and reason for hysterectomy, if documented. Information regarding the type of hysterectomy (whether or not the cervix was removed) was not systematically documented in the electronic medical record and was not collected. A history of abnormal results of screening for cervical dysplasia was determined by reviewing all electronic laboratory records for screening for cervical dysplasia, which dated back to 2002. We also reviewed progress notes for a history of abnormal screening for cervical dysplasia results. After the paper data abstraction was completed, two persons entered the data by hand into an Access database designed for this study (Microsoft Corporation, Redmond, Washington, USA). Quality assurance was performed on the dataset including comparison of the paper and electronic database for a subset to ensure against data entry errors.

Statistical Analysis

Our primary outcome was screening for cervical dysplasia during 2007. We categorized all continuous variables for univariate and multivariate analysis, because they were not normally distributed. Age was categorized based on differences in DHHS [6] recommendations for screening for cervical dysplasia for healthy women. CD4 cell count was divided by categories that differ by risk. The lower limit of detection for viral load for some samples during the study period was 400 copies/mL. We further divided detectable viral load into groups to examine for a trend with increasing viral load. We estimated median per capita income by matching individual zip codes to the 2000 USA census data, which the most recent census was taken prior to the study period, because no other income data were available. We categorized income to facilitate comparison with data from a well-known cohort, the Women's Interagency

Health Study reported by Adeyemi et al. [25]. Women diagnosed with HIV infection in 2006 or 2007 were analyzed as having a diagnosis of HIV infection for one year or less duration. We classified patients by whether they had <4 or ≥ 4 primary care visits, because of recommendations for visits every 3–4 months according to DHHS for the study period. We also classified patients by whether they saw one or more than one attending provider or had missed any appointments during 2007. Race/ethnicity was separated into black non-Hispanic, white non-Hispanic, Hispanic any race, or other. Women listed as Hispanic were included in that category only. Among seven women with more than one HIV-related risk factor listed, we used only the factor associated with the highest risk for transmission (i.e., we considered intravenous drug use to be higher risk than heterosexual sex). When documented, reasons for having had a hysterectomy were categorized as benign or not; non-benign reasons included history of advanced cervical dysplasia, cervical cancer, or other uterine malignancy. Because USPSTF recommendations [26] against screening women ≥ 65 years of age who have been adequately screened and do not have a history of high-grade lesions and against screening women who have undergone hysterectomy with removal of the cervix for benign reason do not apply to women who are immunocompromised (such as those with HIV infection), we included these women within our cohort.

Non-parametric, equality-of-medians tests were only used to compare medians of continuous variables between the overall study population and the subgroup of women with CD4 count ≤ 50 cells/mm³ during 2007. We used a Wald p-test for trend to test for trends in screening prevalence over increasing values of categorized continuous variables. For categorical variables, we used a continuity-corrected χ^2 test to compare proportions among women who were or were not screened. We performed log-binomial regression, rather than logistic regression, to directly calculate adjusted and unadjusted prevalence ratios for screening for cervical dysplasia. Clinic setting was included as an independent variable in multivariable analyses to adjust for differences between clinics. Adjusted estimates controlled for

predictors identified in previous studies, including age, race/ethnicity, number of primary care visits in 2007, current CD4 count (latest CD4 cell count recorded during 2007), and history of abnormal results of screening for cervical dysplasia. We tested for multicollinearity in our multivariate model, which was not detected. We addressed missing data by using model-wise deletion. All statistical analyses were performed using Stata Intercooled 12 (Stata Corporation, College Station, Texas, USA).

Results

The study sample consisted of 498 women with HIV infection. Table 1 shows the demographic characteristics of our study sample. The median age was 43 years (IQR: 34–51 years). Black women composed the largest racial/ethnic group in our study (73%). Hispanic women were next most represented (19%). Most (89%) lived in a zip code where the median per capita annual income was ≤\$24,000. Most (85%) women in our study reported heterosexual contact as their only risk factor for HIV infection. Only 49 (10%) reported intravenous drug use. During 2007, 387 (78%) women were on HAART; however, only 231 (51%) had undetectable HIV RNA during the year.

The median current CD4 count among all women was 439 cells/mm³ (IQR: 252–648).

Of note, we found that 6% (n = 28) of our study population had a CD4 count ≤50 cells/mm³ during 2007, in spite of being in care. We characterized these women further to examine how they might differ from the overall study sample (Table 1). Women with very low CD4 count were of similar age (median age: 39 vs. 43 years, *P* = 0.20), race/ethnicity (75% black in both groups), and had similar levels of current tobacco use (32 vs. 26%, *P* = 0.48) when compared with women with higher CD4 counts. Fifty-four percent of these severely ill women had <4 primary care appointments in 2007. Only eight (29%) of these women were screened for cervical cancer. Most (75%) of these women were on HAART during 2007, but, as suggested by the low CD4 cell counts, only one had an undetectable viral load. The median viral load was higher than that observed among the overall study sample. Among 25 women with CD4 count ≤50 cells/mm³ and known duration of HIV infection, five (20%) had been diagnosed with HIV within the year prior to the study period.

Table 1: Demographic characteristics of a sample of women with HIV infection receiving care in the Harris Health System and further characterization of the subgroup of women with current CD4 cell count ≤50 cells/mm³, 2007.

Characteristic	Total study sample (n = 498)	Women with CD4 count ≤50 cells/mm ³ (n = 28)*
Any Pap screening during year, n (%)	258 (52)	8 (29)
Age (yrs), median (IQR)	43 (34–51)	39 (33–49)
Race/ethnicity, n (%) [†]		
Black	364 (73)	21 (75)
White	34 (7)	2 (7)
Hispanic	95 (19)	5 (18)
Other	5 (1)	0 (0)
Per capita income by zip code, n (%)		
<\$12,000	148 (30)	9 (32)
\$12,000–\$24,000	294 (59)	17 (61)

>\$24,000	56 (11)	2 (7)
Current tobacco use, n (%)	130 (26)	9 (32)
Current alcohol abuse, n (%)	41 (8)	2 (7)
HIV Risk Behavior, n (%)		
Heterosexual	423 (85)	26 (93)
IVDU	49 (10)	2 (7)
Other	13 (3)	0 (0)
Unknown	13 (3)	0 (0)
Number of primary care appointments in 2007, n (%)		
2	130 (26)	12 (43)
3	144 (29)	3 (11)
4	89 (18)	6 (21)
≥5	135 (27)	7 (25)
Care setting, n (%)		
Specialty care	401 (81)	23 (82)
Family practice	97 (19)	5 (18)
Years since HIV diagnosis, n (%)		
≤1 yr	71 (18)	5 (20)
2–10 yrs	233 (58)	13 (52)
>10 yrs	101 (25)	7 (28)
Currently on HAART, n (%)	387 (78)	21 (75)
Current CD4 count (cells/mm ³), median (IQR)	439 (252–648)	31 (23–41)
Nadir CD4 count (cells/mm ³), median (IQR)	209 (60–344)	14 (6–23)
Current log ₁₀ HIV RNA, median (IQR)	2.6 (2.6–4.5)	5.7 (4.9–5.8)
Undetectable HIV RNA during 2007, n (%)	231 (51)	1 (4)

* Numbers may not add up to 28, because all data were not available for all variables on all patients.

†Per capita income for zip code, based on 2000 census data. Percentages may not add up to 100% because of rounding error.

IVDU, intravenous drug use

IQR, interquartile range

Fifty-two percent of women (n = 258) underwent screening for cervical dysplasia during the year. There was no significant difference in screening rates among women with a documented referral compared to those without a referral (50% vs. 53%, *P* = 0.5). In unadjusted analyses, a higher proportion of women who attended ≥4 primary care visits during 2007 had been screened, compared with women who attended <4 primary care visits

(49% vs. 40%, *P* = 0.05; Table 2). Nadir CD4 count was not associated with screening, but higher current CD4 count was. The prevalence of screening among women with CD4 cell counts ≥350 cells/mm³ was higher than women with CD4 counts <200 cells/mm³ (66% vs. 16%, *P*<0.001). Women of Hispanic ethnicity were screened more often than black women. There was a trend toward decreased screening among older

women, women ≥ 65 years were less likely to be screened than women < 30 years (PR: 0.37; 95% CI: 0.13–1.03), but this difference was not significant. Estimated per capita income, the number of attending providers seen during the year, specialty versus primary care, and the number of missed appointments were not associated with screening (data not shown). Similarly, duration of HIV infection, HAART prescription, AIDS diagnosis, and HIV RNA titer in 2007 did not predict screening status. The likelihood of screening also did not differ by history of abnormal screening or hysterectomy. However, fewer women who underwent hysterectomy for a benign reason were screened than women who underwent hysterectomy for treatment of cervical cancer or dysplasia ($P = 0.09$; data not shown).

In adjusted analyses, number of primary care visits attended during 2007 remained associated with significantly increased prevalence of screening (aPR ≥ 4 vs. < 4 visits: 1.21; 95% CI: 1.02–1.44). Prevalence of screening among women with > 350 cells/mm³ compared to women with < 200 cells/mm³ also remained significantly greater (aPR: 1.30; 95% CI: 1.00–1.70). In addition, the increase in screening among women of Hispanic ethnicity compared with black women remained significant in adjusted analyses (Table 2). The difference in screening by age developed significance in adjusted analyses: women ≥ 65 years were significantly less likely to be screened than women < 30 years (aPR: 0.31; 95% CI: 0.11–0.87).

Table 2: Unadjusted and adjusted prevalence ratios of factors associated with cervical cancer screening in HIV-infected women in care in the Harris Health System, 2007.

Characteristic	Screened No. (%) (n = 258)*	Not screened No. (%) (n = 40)*	Unadjusted Prevalence Ratio (95% CI)	Adjusted Prevalence Ratio [†] (95% CI)
Demographic characteristics				
Age (years)				
<30	28 (11)	20 (8)	REF	REF
30–50	157 (61)	151 (63)	0.87 (0.67–1.14)	0.84 (0.66–1.09)
50–64	70 (27)	58 (24)	0.94 (0.70–1.25)	0.86 (0.65–1.13)
≥ 65	3 (1)	11 (5)	0.37 (0.13–1.03)	0.31 (0.11–0.87)
Race/ethnicity				
Black	181 (70)	183 (76)	REF	REF
White	17 (7)	17 (7)	1.01 (0.71–1.43)	0.98 (0.70–1.38)
Hispanic	58 (22)	37 (15)	1.23 (1.01–1.49)	1.27 (1.05–1.52)
Other	2 (1)	3 (1)	0.80 (0.27–2.37)	0.79 (0.27–2.33)
Characteristics of care delivery				
Clinic setting				
Specialty care	205 (51)	196 (49)	REF	REF
Family practice	53 (55)	44 (45)	1.07 (0.87–1.31)	0.96 (0.78–1.18)
Number of primary care visits in 2007				
<4	131 (51)	143 (60)	REF	REF
≥ 4	127 (49)	97 (40)	1.19 (1.00–1.40)	1.21 (1.02–1.44)

Risk behaviors				
HIV risk factors				
Heterosexual contact	228 (88)	195 (81)	REF	
IVDU	20 (8)	29 (13)	0.76 (0.53–1.07)	
Other	4 (2)	9 (4)	0.57 (0.25–1.30)	
Unknown	6 (2)	7 (3)	0.86 (0.47–1.55)	
Current tobacco use	65 (25)	65 (27)	0.95 (0.78–1.16)	
Current alcohol abuse	22 (9)	19 (8)	1.04 (0.77–1.40)	
Characteristics of HIV disease				
Years since HIV diagnosis				
≤1	41 (18)	30 (17)	REF	
2–10	130 (58)	103 (57)	0.97 (0.77–1.22)	
>10	53 (24)	48 (27)	0.91 (0.69–1.19)	
Taking HAART	205 (80)	182 (76)	1.14 (0.91–1.43)	
Diagnosed with AIDS	133 (52)	125 (53)	0.99 (0.84–1.17)	
Nadir CD4 count (cells/mm ³)				
CD4 ≥350	58 (22)	63 (26)	REF	
CD4 200–349	75 (29)	59 (25)	1.17 (0.92–1.48)	
CD4 <200	125 (48)	118 (49)	1.07 (0.86–1.34)	
Last CD4 count in 2007 (cells/mm ³)				
CD4 ≥350	169 (66)	142 (60)	REF	REF
CD4 200–349	48 (19)	36 (15)	1.05 (0.85–1.30)	1.04 (0.85–1.27)
CD4 <200	40 (16)	59 (25)	0.74 (0.57–0.96)	0.77 (0.59–1.00)
Last HIV RNA in 2007 (copies per mL)				
≤400	129 (54)	102 (47)	REF	
401–20,000	55 (23)	44 (20)	0.99 (0.81–1.23)	
20,000–100,000	25 (11)	33 (15)	0.77 (0.56–1.06)	
100,000–500,000	17 (7)	19 (9)	0.85 (0.59–1.22)	
>500,000	12 (5)	21 (10)	0.65 (0.41–1.04)	
Gynecologic History				
No history of abnormal cervical screening test	139 (52)	126 (48)	REF	REF
History of abnormal cervical cancer screening test	111 (56)	86 (44)	1.07 (0.91–1.27)	1.07 (0.91–1.26)
Previous hysterectomy	49 (19)	36 (15)	1.14 (0.93–1.40)	

*Totals may not add up to 498 because of missing values. Totals may not equal 100% because of rounding.

†Factors for which estimates are listed were included in the multivariable model.

CI, confidence interval

IVDU, intravenous drug use

HAART, highly active antiretroviral therapy

Discussion

Our study is one of the first to evaluate screening for cervical dysplasia among women with HIV infection in a large metropolitan area in the southern USA with high rates of HIV. We found that only 52% of women in established care for HIV infection were screened for cervical cancer during a 12-month period. The reason for this low screening rate is unclear but may have been related to workflow of the clinic at that time. We observed no clear relationship between whether a woman had a referral to gynecology on file and whether she underwent screening. Specifically, some women without documented referrals still underwent screening. In fact, only 40% of women in our sample had documented referrals. Furthermore, women who were not screened were not documented as having refused screening. The recommendations for annual screening have been well established; there is no reason to believe that these caregivers, who care almost exclusively for patients with HIV infection, were unaware of the recommendation to screen this group of women. In addition, this low rate was observed despite a special focus documented by the New York State Department of Health AIDS Institute [27] on improving screening for cervical dysplasia rates among Ryan White-supported facilities during 2007 and patient assistance offered in these clinics to overcome barriers to care, such as cost, transportation, and access to specialists. We noted that women who had ≥ 4 primary care visits during 2007 were more likely to have been screened. This finding may suggest that women with more visits had greater opportunity to address preventive care concerns. Thompson and colleagues [28] have discussed the importance of retention in care as a determinant of HIV treatment success, but the association between retention in care and screening for cervical dysplasia rates has been evaluated infrequently.

Our observed screening rate of 52% during one calendar year is within the range reported in the literature, 26–88% observed

over periods ranging from 6 months to 3 years, but is well below national screening targets for this population determined by DHHS HRSA [29]. Although the rates observed in the studies performed by Oster, Sullivan and Blair [7] and Stein et al. [15] were higher than our observed rate, because their findings were based on self-report, they may have overestimated actual screening rates, as has been shown by Powe and Cooper [30] and Fowles et al. [31]. Our observed rate is among the lowest seen in similar settings in the USA and was recently confirmed by Fletcher and colleagues [32] among women smokers in one of our study clinics during a later time period in spite of efforts made in the clinic to increase screening rates. The discrepancy between referral rate and screening rate could indicate a deficiency in referrals among clinic practitioners but also suggests that women who are referred are not completing their screening visits. Our lower rate could suggest that findings in large metropolitan areas in the northeastern or western USA may not generalize to women living with HIV in the southern United States and that tailored research will be needed to design effective interventions for that population. We find it particularly concerning that the screening rate remains low, even in a setting where cost should not be inhibitory and where screening is provided in the same setting as primary care.

Thompson and colleagues [28] have shown that retention in care is associated with improved patient HIV disease-related outcomes and perhaps with decreased transmission. In Taiwan, Chen and colleagues [17] observed an association between retention in care and screening for cervical dysplasia. Because DHHS [33] recommended that HIV-infected patients be monitored every 3–4 months during 2007, attendance at ≥ 4 primary care visits in a year could be considered an approximation of retention in care. Indeed, Richey et al. [34] noted that the number of visits to an HIV physician in a 6-month period predicted retention in care. Mugavero and colleagues [35] identified six potential measures of retention in care, which relate to kept and missed HIV primary care visits and correlated well with viral load suppression. Although other studies evaluating factors associated with screening for cervical

dysplasia in women with HIV infection have considered missed appointments, only Leece and colleagues [13] in Canada examined the relationship between appointment number and screening for cervical dysplasia. They further noted that the likelihood of having been screened during a 3-year period increased as the number of visits increased during the same period. However, they only found a significant difference when they compared women with >9 visits with women with one visit. Our study is the first in the USA to show that women who had equal to or greater than the number of yearly visits recommended by DHHS guidelines were more likely to receive appropriate cervical cytology screening.

Numerous studies [7, 8, 13, 18] have also reported an association between CD4 counts >200 and an increased likelihood of being screened, which has not been established as a measure of retention in care but, according to Richey et al. [34], could be correlated. One possible explanation for this trend might be decreased emphasis by providers on preventive care in patients who are very ill and likely not adherent to therapy. Although Richey et al. [34] observed that both CD4 count and number of visits correlated with retention in care, these two measures did not exhibit collinearity in our model, and so both were included. This finding suggests that these two measures may correlate with different aspects of retention in care, such as medication adherence and visit adherence. The correlation we observed between number of visits and screening for cervical dysplasia suggests that the benefits of successful retention in care could extend beyond improving laboratory parameters to adherence to preventive care recommendations. Interventions made to improve retention in care might also improve rates of screening for cervical dysplasia.

Race/ethnicity and age, which were associated with screening in our study, have been associated with screening in other studies as well. Kaplan and colleagues [18] noted increased rates of screening among Hispanic women with HIV infection as we did; however, Baranoski and associates [8] observed that Hispanic women with HIV infection were less likely to be

screened. Logan and colleagues [9], Shah and associates [14], and Stein et al. [15] observed no relationship between race/ethnicity and screening. The potential relationship is important in light of the increased risk for developing cervical cancer. Howlader and colleagues [36] have observed among Hispanic women. Additionally, Chapman Lambert [16], Peterson et al. [37], and Coughlin and associates [38] have observed that differences in likelihood of screening among different ethnic and racial groups may be modified by educational level, income, geography, and other factors.

Several studies [7, 8, 10, 11, 13, 16, 37] in addition to the current study have observed an association between younger age and increased screening, and lower screening rates are observed among older HIV-infected and – uninfected women worldwide. Reasons for this trend are unknown but are concerning. During 2005–2009, according to USA Surveillance Epidemiology and End Results, 19.4% of cervical cancer cases were diagnosed among women >65 years old regardless of HIV status [39]. One possible explanation is confusion among providers or among patients with regard to screening recommendations for women with HIV in this age group, because healthy women in this age group may safely forgo screening according to DHHS guidelines [26]. That fewer women in our cohort who underwent hysterectomy for benign reasons were screened may serve as additional evidence of confusion regarding the applicability of these guidelines to women with HIV infection.

This study has limitations and strengths. Our sample size may not have the power to detect some predictors of screening. However, our sample size is similar to those used in previous studies. Because data were collected by medical record review, some variables of interest were not systematically present for all women, including primary language spoken, country of birth, education, insurance status, degree of adherence to HAART, and gynecologic history, including type of hysterectomy. However, we were able to estimate socio-economic status by using population-level income data. Because this was a cross-

sectional study, women whose two qualifying primary care visits occurred near the end of the study period might not have had equal opportunity for screening during the study period. However, these women likely represent a very small proportion of our sample, and our data still provide a cross-sectional understanding of the screening rates at that time. Furthermore, our convenience sample differed from the source population by age only and was similar with regard to other characteristics. Finally, our study was conducted among women in the southern USA and our findings may not generalize to other populations. However, this difference emphasizes that findings from previous studies may not generalize to all women with HIV infection living in large metropolitan areas in the USA or other countries.

Despite their increased risk for developing cervical dysplasia and cancer, and the efficacy of screening in preventing cervical cancer, women with HIV infection in one metropolitan area in the southern USA continue to be screened at low rates. Factors associated with screening in this under-studied geographic area differ from those observed in other geographic areas. Interventions to improve screening rates may need to be tailored to different geographic areas, even within the USA. We found that older age and a lower number of primary care visits, which can be associated with retention in care, were associated with low rates of screening. These findings suggest that focusing on interventions to improve retention in care may result in benefits beyond suppressed viral loads. Given the increased risk of cervical cancer among women with HIV infection, strategies for improving screening in this population are needed.

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