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ORIGINAL PAPER

Patterns of HIV testing among women diagnosed with invasive cervical cancer in the New Jersey Medicaid Program

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Abstract

Purpose Practice-based guidelines recommend HIV testing during initial invasive cervical cancer (ICC) workup. Determinants of HIV testing during diagnosis of AIDS-defining cancers in vulnerable populations, where risk for HIV infection is higher, are under-explored.

Methods We examine factors associated with patterns of HIV testing among Medicaid enrollees diagnosed with ICC. Using linked data from the New Jersey State Cancer Registry and New Jersey Medicaid claims and enrollment files, we evaluated HIV testing among 242 ICC cases diagnosed from 2012 to 2014 in ages 21–64 at (a) any point during Medicaid enrollment (2011–2014) and (b) during cancer workup 6 months pre ICC diagnosis to 6 months post ICC diagnosis. Logistic regression models identified factors associated with HIV testing.

Results Overall, 13% of women had a claim for HIV testing during ICC workup. Two-thirds (68%) of women did not have a claim for HIV testing (non-receipt of HIV testing) while enrolled in Medicaid. Hispanic/NH-API/Other women had lower odds of non-receipt of HIV testing compared with NH-Whites (OR: 0.40; 95% CI: 0.17–0.94). Higher odds of non-receipt of HIV testing were observed among cases with no STI testing (OR: 4.92; 95% CI 2.27–10.67) and < 1 year of Medicaid enrollment (OR: 3.07; 95% CI 1.14- 8.26) after adjusting for other factors.

Conclusions Few women had HIV testing claims during ICC workup. Opportunities for optimal ICC care are informed by knowledge of HIV status. Further research should explore if lack of HIV testing claims during ICC workup is an accurate indicator of ICC care, and if so, to assess testing barriers during workup.

Keywords HIV testing · Invasive cervical cancer · Medicaid · AIDS-defining cancer

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Introduction

The American Cancer Society estimates approximately 13,000 new cases of invasive cervical cancer (ICC) will be diagnosed annually in the United States (U.S.) and one-in-three women will likely die as a result [1]. Persistent infection with high-risk human papillomavirus (HPV) is associated with the development of 90% of cervical cancer cases [2–4]. Known risk factors for cervical cancer are smoking, long-term contraceptive use, obesity, multiparous, multiple sexual partners, Chlamydia infection, and having a compromised immune system caused by the Human Immunodeficiency Virus (HIV) [5, 6]. Women with persistent HPV infection who are co-infected with HIV are at increased risk of developing precancerous lesions and ICC due to the natural history of HPV and HIV and disparate health care delivery patterns in cancer prevention [7–13]. Infection rates

of both HPV and HIV viruses are significantly higher among low-income, racial/ethnic minority subgroups, and other vulnerable populations [14–16].

The Centers for Disease Control and Prevention (CDC) identifies cervical cancer as an Acquired Immune Deficiency Syndrome (AIDS) defining cancer [17]. Having an AIDS-defining cancer means coinfection with HIV can make the natural history of cancer more virulent due to HIV-related immunodeficiency [11, 17]. Beginning in 2006, the CDC recommended routine HIV testing for patients aged 13 to 64 years within all health care settings (e.g., hospitals, emergency rooms, primary care settings) in addition to areas where HIV prevalence is greater than 0.1% of the population. This change represents a shift from risk-based testing to the implementation of routine HIV testing because risk-based HIV testing has failed at identifying patients with unknown HIV status [18–20]. The U.S. Preventive Services Task Force (USPSTF) also recommends screening for HIV infection in all adolescents and adults aged 15 to 65 years [21].

For women with health care encounters that include cervical cancer screening or follow-up for abnormal results, two national guidelines address assessment of HIV status during ICC workup. The American Society for Colposcopy and Cervical Pathology (ASCCP) suggests HIV status should be documented as part of a comprehensive colposcopy practice, especially in the presence of precancerous cervical lesions [22]. The National Comprehensive Cancer Network (NCCN) guidelines for ICC diagnosis and management state that clinicians should "consider HIV testing, especially in younger patients" at initial cancer workup. [23, 24]. Globally, the International Federation of Gynecology and Obstetrics (FIGO) and the World Health Organization (WHO) in their plan to eliminate cervical cancer have emphasized the importance of HIV prevention, care, and treatment [25, 26]. HIV testing in cancer centers and oncology practices is also considered an important setting to determine HIV status, especially since people living with HIV are at an increased risk for malignancies and an estimated 12% of women in the U.S. are unaware of their positive HIV status [27, 28]. A recent study examined HIV testing within a gynecologic oncology department at the beginning of their cancer treatment and showed improved HIV testing rates from 3 to 50% [29]. While the number of cases appears low, the rates of HIV infection within these settings (0.18% and 1.1%, respectively) still exceeded the 0.1% limit set forth by the CDC and USPSTF. Knowledge of HIV status can inform several aspects of care for patients with ICC, including the need to start HIV antiretroviral therapy in HIV-infected women, to plan for the potential impact that cancer treatment can cause on a compromised immune system, to coordinate and improve care coordination between medical specialties, and to monitor for potential interactions between HIV and cancer drugs [30–33].

Although multiple international studies to date have focused on HIV testing during cancer treatment [34–37], few studies in the U.S. have explored HIV testing patterns among newly diagnosed cases of cervical cancer, particularly among low-income women at higher risk of HIV infection. In the general population, HIV testing rates remain low with one study reporting 2.8% of privately insured and 4.3% of Medicaid enrollees ever being tested [38]. One study at a single cancer center found that 18.6% of cancer patients were tested for HIV including 11% of those with AIDS-defining cervical cancer [39]. Reasons for low HIV testing rates are not just multifactorial but also multilevel with patient, provider, and health care system-related barriers and facilitators [40–42]. Health insurance status and primary care physician involvement have been found to be important determinants of HIV testing overall [18, 43]. Structural barriers to HIV testing, including insurance coverage and having a regular physician, as well as other area-level factors, such as poverty and urbanization, are important to understanding the dynamics of HIV as they relate to HIV prevention, transmission, testing, and treatment [40, 44–47]. However, these factors have not been examined among ICC cases especially in areas where HIV is considered a concentrated epidemic (prevalence > 0.1%) [14, 48].

We examine patterns of HIV testing and determinants of non-receipt of HIV testing among non-elderly women diagnosed with ICC from 2012 to 2014 in the New Jersey Medicaid program. Using the Advancing Health Disparities Research within the Health Care System conceptual framework [49], we explore patient-, health care-, and area-level factors associated with non-receipt of HIV testing.

Methods

Study population

This study focuses on a subset of ICC cases from a larger data linkage established to understand patterns of care among Medicaid enrollees in New Jersey between the ages of 21 and 64. For the larger data linkage, eligible cases with a first primary breast, colorectal, or invasive cervical cancer identified by the New Jersey State Cancer Registry (NJSCR) were linked to 2011–2014 New Jersey Medicaid claims and enrollment files. Cancer cases who were identified by a death certificate, autopsy, and non-New Jersey residence at time of diagnosis and those who had a previous primary cancer were excluded. Additional details about the data linkage and study population are described in our prior work [50]. For this analysis, we specifically focused on non-elderly women diagnosed with a primary, histologically confirmed ICC at

age 21 to 64 between 1 January 2012 through 31 December 2014 and were enrolled in the Medicaid program at the time of ICC diagnosis from the linked dataset. The age group spanning ages 21 to 64 was chosen because Medicaid is the largest public health insurance program in the U.S. mainly for individuals under age 65 with income at or below 138% of the federal poverty level and cervical cancer screening guidelines begin at age 21 [51, 52]. Cases of HIV/AIDS were excluded from the study population using the Charlson comorbidity index for HIV/AIDS [53–55]. The study protocol was approved by the Rutgers Biomedical Health Sciences New Brunswick Institutional Review Board.

Measures

Outcome measures

The main study outcome of interest was non-receipt of HIV testing (i.e., those who did not have a documented HIV testing Medicaid claim) at two time periods: (a) any point during the study period (2011–2014) while enrolled in Medicaid and (b) cancer workup: the 6 months before the diagnosis of ICC, including clinical evaluations that yielded an abnormal cervical cancer cytology result or the diagnosis of cervical intraepithelial neoplasia (CIN), or the 6 months after the diagnosis of ICC, including clinical evaluations or laboratory testing to guide the ICC treatment plan. We define the cancer workup period to be six months before through 6 months after cancer diagnosis because it includes the processes of care related to screening, receipt of an abnormal Pap, follow-up procedures for diagnosis, and additional follow-up tests to complete cancer staging [56]. ICD-9 codes were used to identify receipt of HIV test (V70.0, V73.89, V69.8, V65.44, V08, and V042) during the two time periods from Medicaid claims for each ICC case.

Main predictors

Patient characteristics

Sociodemographic characteristics from NJSCR included race/ethnicity (Non-Hispanic White [NH-White], Non-Hispanic Black [NH-Black], Hispanic/Non-Hispanic Asian/Pacific Islander/Other race [Hispanic/NH-API/Other]), age of diagnosis (< 30–39, 40–49, 50–64), year of diagnosis, histology, and stage at diagnosis. Cancer histology was based on International Classification of Disease for Oncology, 3rd Ed. (ICD-0-3) and included squamous/transitional cell carcinoma, adenocarcinoma, and other/unknown. Stage was defined as in situ/local, regional, and distant/unknown based on SEER Summary Stage 2000. Medicaid claims were used to define number of comorbidities and bacterial sexually transmitted infection (STI) testing for chlamydia, gonorrhea, and syphilis. Claims were also used to identify the number of comorbidities based on the Charlson comorbidity index (excluding cancer and HIV) up to a year prior to ICC diagnosis [53–55]. ICD-9 codes, Healthcare Common Procedure Coding System (HCPCS) codes, and Current Procedural Terminology (CPT) codes were used to identify bacterial STI tests for chlamydia, gonorrhea, and syphilis in the claims data and dates of STI testing (Table 3 in Appendix). Any bacterial STI testing done during the study period was categorized as yes (having at least one test).

Healthcare characteristics

Medicaid enrollment characteristics obtained from monthly Medicaid enrollment and claims files included Medicaid eligibility category, length of enrollment prior and after diagnosis, and managed care plan enrollment. In the year prior to ICC diagnosis, Medicaid eligibility criteria were categorized as (a) General Assistance/Expansion population, including childless adults below 24% of the federal poverty level (FPL) and those newly enrolled through Medicaid expansion after 1 January 2014; (b) the aged, blind, and disabled (ABD) and higher-income ABD individuals who received eligibility after exhausting their financial means due to health expenses; and (c) NJ Family Care which covers caretakers and parents of children up to 200% of the FPL. Enrollment length (in months) was captured for the 12 months pre diagnosis and 12 months post diagnosis. Length of enrollment was categorized as full year (≥ 11 months) and less than a year (< 11 months). Few cases in our study population had gaps in enrollment (> 30 days) [50]. Managed care (MC) status was captured for the year prior to ICC diagnosis and categorized as newly enrolled (6-month enrollment), fee-for-service only (FFS), enrolled in managed care only (MC), or enrolled in a mixture of FFS/MC. Ambulatory care visits (i.e., primary care or outpatient specialties, including cardiology, endocrinology, obstetrics/gynecology) were identified from claims using ambulatory-based evaluation and management CPT/HCPCS codes [50]. Number of ambulatory visits pre- and post diagnosis were then categorized as no visits and one to more than three visits.

Area-level measures

We included two area-level characteristics: median household income and population density. We use population density as a proxy for urbanicity as it correlates with HIV prevalence [57]. Population density was obtained using residential zip code at time of diagnosis from the NJSCR for each ICC case; we identified zip-code tabulation area-level population density and median household income from the 2008–2012 American Community Survey using each patient's zip code at time of diagnosis from cancer registry

information. Each area-level characteristic was then further categorized into tertiles based on the distribution of the analytic sample for this analysis. We compared cases living in the highest tertile (tertile 3) for each measure with the lower tertiles (tertiles 1 and 2).

Statistical analyses

Descriptive statistics were used to summarize the patient, health care, and area-level characteristics of the study population. We conducted bivariate logistic regression models to examine patterns of non-receipt of HIV testing by each patient, health care, and area-level characteristic. In the unadjusted and adjusted models, we used non-receipt of HIV testing at any point during the study period (2011–2014). Covariates were considered for the adjusted model if the p values of the bivariate associations were less than 0.20 or if they were known confounders based on prior literature. We then used multivariable logistic regression models to examine non-receipt of HIV testing at any point during the study period and at cancer workup by patient, health care, and area-level characteristic. Odds ratios (OR) were reported along with 95% confidence intervals (CIs) and determined statistical significance at the $p < 0.05$ level. All analyses used Stata version 15 and were completed in 2018.

Results

A total of 242 cases diagnosed with ICC from 2012 to 2014 were included in the final analytic cohort (Table 1). Most were racial/ethnic minorities (59%) who had no reported comorbidity in the year prior to diagnosis (85%). Squamous and transitional cell carcinomas were most commonly diagnosed (73%) and the majority of ICC cases were diagnosed at in situ/localized or regional stages (78%). Only 20% of the study population had any bacterial STI testing for both Chlamydia and Gonorrhea based on Medicaid claims. Greater than half (57%) were enrolled in Medicaid for less than a full year in the 12 months prior to ICC diagnosis. However, 58% remained enrolled for the full year after diagnosis. Most (72%) did not receive ambulatory care before diagnosis.

Approximately two-thirds of the total population did not receive any HIV testing during their Medicaid enrollment at any point during the study period (2012–2014), while a third ($n = 78$) received at least one HIV test. More specifically, 13% ($n = 33/242$) of the total population received an HIV test during the cancer workup (i.e., 6 months pre/post ICC diagnosis). Year of diagnosis, bacterial STI testing, being newly enrolled, number of ambulatory visits pre diagnosis, and length of Medicaid enrollment pre and post diagnosis were significantly associated with non-receipt of any HIV testing in the bivariate models (Table 2). In the adjusted model, the odds of non-receipt of HIV testing were 0.40 (95% CI: 0.17–0.94) times lower for Hispanic/NH-API/Other race/ethnicity compared with NH-White women. The odds of not receiving a HIV test were 4.92 (95% CI: 2.27–10.67) times higher for women who did not receive any bacterial STI test compared with women who had at least one bacterial STI test. Compared with women enrolled in Medicaid for at least a full year (≥ 11 months) before cancer diagnosis, the odds of not receiving a HIV test were 3.07 (95% CI: 1.14–8.26) times higher for women enrolled for less than a full year (< 11 months). Non-receipt of HIV testing did not differ by area-level characteristics of population density or median household income in the adjusted model.

Discussion

To our knowledge, this is one of the few studies to report prevalence of HIV testing and examine determinants of HIV testing among Medicaid enrolled women diagnosed with ICC. We found two-thirds of women in our study did not have a Medicaid claim for a HIV test at any point in our study period. Only 13% (33/242) had a claim for HIV testing during the cancer workup period. These findings suggest low receipt of HIV testing among women recently diagnosed with ICC and enrolled in Medicaid. Timely HIV diagnosis and treatment can reduce potential complications from cancer treatment due to a compromised immune system, which is important for a population that may experience increased treatment delays and suboptimal cancer care [58]. These patterns are concerning for a state like New Jersey where rates of HIV/AIDS and ICC incidence are higher than the national average [43, 59]. Medicaid is the largest provider of health care coverage for low-income and vulnerable populations. In New Jersey, Medicaid covers routine HIV testing with no cost-sharing to the patient as part of their covered services [60]. Therefore, there may be missed opportunities by providers to offer routine testing within all health care settings, including oncology.

Our findings showed higher HIV testing rates compared to rates observed in prior studies focusing on cancer patients. In a U.S. study at a large comprehensive cancer center, HIV tests at initiation of cancer therapy for cervical cancer were reportedly 9.4% [39]. A Swiss study examined ten years of retrospective oncology data and found rates of HIV testing for ICC cases were 11%, which were lower in comparison to other AIDS-defining cancers such as lymphoma (59–60%) and Kaposi Sarcoma (100%) [34]. In the general population, HIV testing was found to be higher in the Medicaid population (4.3%) compared with a commercially insured population (2.8%) [24]. We may have observed higher rates of HIV testing (32%) in our study of ICC cases in the Medicaid program because we are looking at the non-elderly population,

Table 1 Sociodemographic, clinical tumor, health care system and area-level characteristics by receipt of HIV testing among New Jersey Medicaid enrollees diagnosed with invasive cervical cancer, 2012–2014

	Total		Receipt of HIV Testing				
			Yes*		No		
	$n=242$		$n=78$		$n=164$		
			Row Percent				
	n	%	*n*	%	*n*	%	*P*-value
Sociodemographic characteristics							
Race/ethnicity							0.181
Hispanic/NH-API/Other Race	78	32.2	28	35.9	50	64.1	
NH-White	101	41.7	26	25.7	75	74.3	
NH-Black	63	26.0	24	38.1	39	61.9	
Age at diagnosis							0.298
< 30–39 years	79	32.6	29	36.7	50	63.3	
40–49 years	62	25.6	22	35.5	40	64.5	
50–64 years	101	41.7	27	26.7	74	73.3	
Clinical tumor characteristics							
Histology							0.822
Sq./trans. cell carcinoma	176	72.7	56	31.8	120	68.2	
Adenocarcinoma/other/unknown	66	27.3	22	33.3	44	66.7	
Summary stage							0.234
In situ/localized	96	39.7	37	38.5	59	61.5	
Regional	93	38.4	26	28.0	67	72.0	
Distant/unknown	53	21.9	15	28.3	38	71.7	
Year of diagnosis							**0.009**
2012	77	31.8	30	39.0	47	61.0	
2013	96	39.7	20	20.8	76	79.2	
2014	69	28.5	28	40.6	41	59.4	
Co-morbidities[a]							0.816
None	206	85.1	67	32.5	139	67.5	
1+	36	14.9	11	30.6	25	69.4	
Chlamydia test							**0.002**
Yes	49	20.2	25	51.0	24	49.0	
No	193	79.8	53	27.5	140	72.5	
Gonorrhea test							**0.002**
Yes	49	20.2	25	51.0	24	49.0	
No	193	79.9	53	27.5	140	72.5	
STI testing[b]							**< 0.001**
Yes	62	25.6	36	58.1	26	41.9	
No	180	74.4	42	23.3	138	76.7	
Medicaid enrollment characteristics							
Medicaid eligibility							0.232
GA/expansion	58	24.0	21	36.2	37	63.8	
Aged/blind/disabled	90	37.2	23	25.6	67	74.4	
NJ familycare	94	38.8	34	36.2	60	63.8	
MC enrollment[c]							**0.004**
Newly enrolled	63	26.0	12	19.0	51	81.0	
FFS only or mix of FFS/MC	99	40.9	30	30.3	69	69.7	
MC only	80	33.1	36	45.0	44	55.0	
Pre-diagnosis year							
Enrollment length							**0.001**
< 11 months	139	57.4	33	23.7	106	76.3	

Table 1 (continued)

	Total		Receipt of HIV Testing				
			Yes*		No		
	$n=242$		$n=78$		$n=164$		
			Row Percent				
	n	%	*n*	%	*n*	%	*P*-value
≥ 11 months	103	42.6	45	43.7	58	56.3	
Number of ambulatory care visits							**0.075**
0	173	71.5	49	28.3	124	71.7	
1–2	33	13.6	12	36.4	21	63.6	
3+	36	14.9	17	47.2	19	52.8	
Post-diagnosis year							
Enrollment length							**< 0.001**
< 11 months	101	41.7	19	18.8	82	81.2	
≥ 11 months	141	58.3	59	41.8	82	58.2	
Number of ambulatory visits							0.205
0	81	33.5	20	24.7	61	75.3	
1–2	33	13.6	12	36.4	21	63.6	
3+	128	52.9	46	35.9	82	64.1	
Area level characteristics							
Median household income							0.717
Tertile 1 ($0–$44,766)	78	32.2	27	34.6	51	65.4	
Tertile 2 ($44,767–$66,386)	81	33.5	27	33.3	54	66.7	
Tertile 3 ($66,387–$152,411)	83	34.3	24	28.9	59	71.1	
Population density, per sq. mile							**0.044**
Tertile 1 (0–2,102.01)	81	33.5	18	22.2	63	77.8	
Tertile 2 (2,102.02–9,367.297)	82	33.9	33	40.2	49	59.8	
Tertile 3 (9,367.298–51,632.59)	79	32.6	27	34.2	52	65.8	
Timeframe of HIV tests[d] ($n=78$)							
During cancer work-up	33	42.3	33	100.0	–	–	
Outside of cancer work-up period	45	57.7	45	100.0	–	–	

Statistically significant of p-values < 0.05 are highlighted in bold

FFS Fee-for-service, *MC* managed care, *GA* general assistance

[a]Co-morbidities were calculated using the Charlson comorbidity index, which excluded cancer & HIV

[b]STI testing includes at least one STI test: Chlamydia, Gonorrhea, or Syphilis Test

[c]MC vs FFS enrollment was based on most days enrolled in each category in 12 months prior to diagnosis

[d]Cancer work-up period was determined by HIV testing that occurred within 6 months pre/post ICC diagnosis

[*]HIV testing received at any point during Medicaid enrollment

which may represent ages where more HIV testing occurs. In addition, higher rates of HIV testing in Medicaid may be attributed to the fact Medicaid programs cover HIV care for 47% of individuals with HIV [60]. Therefore, providers may be more primed to test for HIV in the Medicaid population. Two additional Medicaid enrollee studies examined HIV testing at first primary STI infection and found rates were as high as 43% and as low as 15% [38, 61–63]. Although bacterial STI testing was also low in our study (26%), those who received a bacterial STI test were more likely to receive HIV testing.

Our study confirmed previous findings that continuous enrollment in Medicaid increased HIV testing. We observed women enrolled in Medicaid for the full year prior to cancer diagnosis were more likely to receive HIV testing compared to women enrolled less than a year. Having Medicaid coverage is important as previous studies have demonstrated adults with Medicaid coverage were more likely to be tested for HIV [64]. Additionally, Medicaid coverage has been demonstrated to provide HIV testing to those considered most vulnerable and at higher risk of acquiring HIV [65, 66]. Provider recommendation plays a critical role in patient

Table 2 Bivariate and multivariable models for HIV testing among Medicaid invasive cervical cancer patients, 2012–2014

	Non-receipt of HIV Test			
	Unadjusted		Adjusted	
	OR	95% CI	OR	95% CI
Sociodemographic characteristics				
Race/ethnicity				
NH-white	1.00	Ref	1.00	Ref
NH-black	0.56	0.29, 1.11	0.61	0.25, 1.44
Hispanic/NH-API/other	0.62	0.33, 1.18	**0.40**	**0.17, 0.94**
Age at diagnosis				
50–64 years	1.00	Ref	1.00	Ref
40–49 years	0.66	0.34, 1.31	0.51	0.21, 1.24
< 30–39 years	0.63	0.33, 1.19	0.83	0.32, 2.19
Clinical tumor characteristics				
Summary stage				
In situ/localized	1.00	Ref	1.00	Ref
Regional	1.62	0.88, 2.98	1.31	0.59, 2.90
Distant/unknown	1.59	0.77, 3.28	1.48	0.60, 3.64
Year of diagnosis				
2012	1.00	Ref	1.00	Ref
2013	**2.43**	**1.24, 4.75**	**2.60**	**1.14, 5.93**
2014	0.93	0.48, 1.82	1.40	0.53, 3.69
Co-morbidities[1]				
None	1.00	Ref	1.00	Ref
1+	1.09	0.51, 2.36	1.61	0.61, 4.25
STI testing[2]				
Yes	1.00	Ref	1.00	Ref
No	**4.55**	**2.47, 8.38**	**4.92**	**2.27, 10.67**
Medicaid enrollment characteristics				
MC enrollment[3]				
MC only	1.00	Ref	1.00	Ref
FFS only or mix of FFS/MC	**1.88**	**1.02, 3.48**	0.87	0.32, 2.40
Newly enrolled	**3.48**	**1.61, 7.49**	0.66	0.14, 3.00
Pre-diagnosis year				
Enrollment length				
≥ 11 months	1.00	Ref	1.00	Ref
< 11 months	**2.49**	**1.44, 4.33**	**3.07**	**1.14, 8.26**
Number of ambulatory visits				
1–3+	1.00	Ref	1.00	Ref
0	**1.83**	**1.03, 3.28**	1.12	0.49, 2.57
Post-diagnosis year				
Enrollment length				
≥ 11 months	1.00	Ref	1.00	Ref
< 11 months	**3.11**	**1.70, 5.66**	1.95	0.67, 5.73
Number of ambulatory visits				
1–3+	1.00	Ref	1.00	Ref
0	1.72	0.94, 3.13	2.07	0.85, 5.05
Area level characteristics				
Median household income				
Tertile 3 ($66,387–$152,411)	1.00	Ref	1.00	Ref
Tertile 2 ($44,767–$66,386)	0.81	0.42, 1.58	0.91	0.40, 2.07
Tertile 1 ($0–$44,766)	0.77	0.39, 1.49	1.55	0.54, 4.49
Population density per sq. mile				
Tertile 3 (9,367.298–51,632.59)	1.00	Ref	1.00	Ref
Tertile 2 (2,102.02–9,367.297)	0.77	0.41,1.46	0.59	0.24, 1.46
Tertile 1 (0–2,102.01)	1.82	0.90,3.66	1.63	0.60, 4.47

Statistically significant of p-values < 0.05 are highlighted in bold

FFS Fee-for-service, *MC* managed care, *GA* general assistance

[a]Co-morbidities were calculated using the Charlson comorbidity index, which excluded cancer & HIV

[b]STI testing includes at least one STI test: Chlamydia, Gonorrhea, or Syphilis Test

[c]MC vs FFS enrollment was based on most days enrolled in each category in 12 months prior to diagnosis

receipt of HIV testing [48, 67]. While not significant in the adjusted model, those who had more ambulatory care visits prior to diagnosis were more likely to receive HIV testing. Other studies have examined quality of care based on primary care utilization prior to cancer diagnoses and its impact on patient care and outcomes [50, 68, 69]. The relationship between no ambulatory visits and increased non-receipt of HIV testing in our study may indicate lack of routine access to or limited engagement with primary care who may be better at recommending the need for routine HIV testing.

Lastly, we did not find a significant association between area-level median household income or area-level population density with receipt of HIV testing in the adjusted analyses. These findings are unexpected given that both individual- and area-level poverty and urban environments are associated with an elevated risk for HIV [70]. Clinicians should encourage high-risk women to have more frequent HIV testing especially given that the New Jersey HIV epidemic falls within urban areas and among racial/ethnic minorities and women [71]. We also expected more HIV testing considering several counties in New Jersey have high HIV prevalence rates. Potential reasons may include prior HIV testing that precluded the need to re-test during ICC workup, lack of clinician awareness of NCCN's statement to consider HIV testing at initial ICC workup, or patient declination of HIV testing during ICC workup. Previous studies suggest when women perceive their community is disproportionately impacted by HIV, they are more likely to receive HIV testing [72, 73]. While area-level median household income and population density were not significant in

our study, which may be due to our homogeneous, small sample of low-income women in New Jersey, there is strong evidence that the role of place is important in understanding receipt of recommended cancer care among vulnerable populations [15, 74–78]. Further research is needed to identify the multilevel influences that impact guideline-concordant HIV testing for low-income women diagnosed with ICC.

Limitations

There are some limitations in our study to be noted. First, one limitation of using claims data is that we are unable to report if women in our study were offered an HIV test and/or refused testing. Women could have disclosed their HIV status to their providers, which would not warrant an additional confirmatory test. Women in our study could have also received free HIV testing outside of the Medicaid program, such as through social service programs, mobile HIV testing units, community-based organizations, and local community health fairs not captured in the Medicaid encounter data and/or preceded the initial ICC workup period [79]. Second, differing lengths of Medicaid enrollment may affect our ability to assess systematic follow-up periods for all ICC cases. For example, 41% of ICC cases were enrolled within three months of diagnosis, limiting the available claims prior to diagnosis. For example, a subset of ICC cases in our study (8%) were enrolled in Medicaid via their participation in the New Jersey Cancer Education and Early Detection Program (NJCEED). It is unclear if women who participated in the NJCEED program received HIV testing prior to Medicaid enrollment. This warrants further exploration. However, we would expect that some testing ordered by clinicians involved in the ICC workup would be captured based on our definition of six months pre and post diagnosis. Another potential limitation is that HIV testing might have been billed under a more comprehensive service and we therefore may have missing HIV testing services within the claims data. Lastly, we were unable to include a linkage to other mandatory lab-based HIV reporting registries. However, our study includes comprehensive Medicaid enrollment information and claims linked to state cancer registry data for all ICC cases diagnosed during our study period.

Conclusion/implications

Our study is one of the few to assess patterns of HIV testing during cancer workup among ICC patients enrolled in Medicaid. Nationally, the National Cancer Institute funds the HIV/AIDS Match Study which establishes risk and surveillance in people living with HIV/AIDS while utilizing data from state and regional cancer and HIV registries [80]. Future research should consider examining linkages between state cancer registries and other public health registries with mandatory lab-based HIV reporting to provide more precise measures of HIV testing and HIV status. Additional next steps should also include increasing awareness and education about the importance of testing for HIV, beyond primary care settings, to include clinicians involved in the ICC workup period, i.e., gynecologists and gynecological oncologists. Additionally, future research on providers and patients' attitudes and barriers to HIV testing during ICC workup would be valuable. As noted by two studies, oncology settings provide an opportunity to identify newly diagnosed cancer cases with HIV [29, 81]. Our study has important implications for clinical practice by highlighting the need to increase clinicians' awareness of recommended HIV testing guidelines. Considering 12% of women nationally are unaware of their positive HIV status and HIV is a known risk factor for ICC, strategies to address missed opportunities for HIV testing at ICC diagnosis for vulnerable populations warrant further exploration, including increased partnerships between HIV prevention and cancer prevention/screening programs.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflicts of interest and have no financial disclosures.

Appendix

See Table 3.

Table 3 CPT/ICD-9/HCPCS STI testing codes for medicaid claims

Chlamydia testing/screening	**CPT:** 86,631, 86,632, 87,110, 87,270, 87,320, 87,490, 87,491, 87,492, 87,800, 87,810 **ICD-9:** V73.88, V73.98, V74.5, V75.9 **HCPCS:** None
Gonorrhea testing/screening	**CPT:** 87,590, 87,591, 87,850, 87,800 **ICD-9:** V74.5, V75.9 **HCPCS Codes**: None
Syphilis testing/screening	**CPT:** 86,592, 86,593, 86,780 **ICD-9**: V74.5, V74.9, V75.9 **HCPCS Codes**: None
HIV testing/screening	**CPT:** 86,689, 86,701 with modifier 92, 86,702, 86,703 with modifier 92, 87,534, 87,535, 87,536, 87,537, 87,538, 87,539, 87,390, 87,390 with modifier 92, 87,391 **ICD-9:** V70.0, V73.89, V69.8, V65.44, V08, V042 **HCPCS Codes:** G0432, G0433, G0435

Statistically significant of p-values < 0.05 are highlighted in bold

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