HIV Testing Among Adolescents With Acute Sexually Transmitted Infections

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abstract

BACKGROUND AND OBJECTIVES: Rates of sexually transmitted infections (STIs) have increased over the decade. Guidelines recommend HIV testing with incident STIs. Prevalence and factors associated with HIV testing in acute STIs are unknown in adolescents. Our objective was to determine the prevalence of completed HIV testing among adolescents with incident STIs and identify patient and health care factors associated with HIV testing.

METHODS: Retrospective study of STI episodes (gonorrhea, *Chlamydia*, trichomoniasis, or syphilis) of adolescents between 13 and 24 years old from July 2014 to December 2017 in 2 urban primary care clinics. We performed mixed effects logistic regression modeling to identify patient and health care factors associated with HIV testing within 90 days of STI diagnosis.

RESULTS: The 1313 participants contributed 1816 acute STI episodes. Mean age at STI diagnosis was 17.2 years (SD = 1.7), 75% of episodes occurred in females, and 97% occurred in African Americans. Only half (55%) of acute STI episodes had a completed HIV test. In the adjusted model, female sex, previous STIs, uninsured status, and confidential sexual health encounters were associated with decreased odds of HIV testing. Patients enrolled in primary care at the clinics, compared with those receiving sexual health care alone, and those with multipathogen STI diagnoses were more likely to have HIV testing.

CONCLUSIONS: HIV testing rates among adolescents with acute STIs are suboptimal. Patient and health care factors were found to be associated with receipt of testing and should be considered in clinical practice.

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WHAT'S KNOWN ON THIS SUBJECT: Previous literature states adolescents have suboptimal HIV testing rates and pediatricians are often unaware of clinical guidelines for HIV testing. Adolescents with sexually transmitted infections (STIs) are at higher risk for HIV and should be considered for initiation of HIV pre-exposure prophylaxis.

WHAT THIS STUDY ADDS: In this study, we found that HIV testing rates among adolescents with STIs are suboptimal. We also identify that patients enrolled in primary care at the clinic sites had increased odds of receipt of HIV testing after STI diagnosis.

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The past decade has seen dramatic increases in sexually transmitted infections (STIs), specifically *Chlamydia*, gonorrhea, syphilis, and trichomoniasis, among the highest in recorded US history.[1] From 2013 to 2017, the STI rates increased by 31%, with gonorrhea and syphilis incidence climbing by 67% and 76%, respectively.[2] Much of the STI burden falls among adolescents and young adults (AYAs). Although youth 15 to 24 years old represent only one-quarter of sexually active individuals, they account for half of incident STIs.[3] Youth with acute STIs are at increased risk of HIV because of both non–condom-protected sexual behavior and genital tract inflammation.[4,5] Over the life span, each STI episode increases one's susceptibility to HIV infection.[6,7]

Recognizing this increased risk, in addition to routine HIV testing, the Centers for Disease Control and Prevention and US Preventative Services Task Force recommend risk-based HIV testing for individuals who test positive for an STI.[8,9] However, these guidelines have not been adequately followed.[9–12] HIV screening rates are as low as 36% among adults and lower among AYAs,[10,13,14] which has contributed to 44% of 13- to 24-year-olds living with HIV being undiagnosed.[15] Undiagnosed individuals living with HIV are at risk for HIV progression and contribute to one-third of HIV transmissions because of uncontrolled HIV viremia.[16–18] Unfortunately, AYAs 13 to 24 years old have the highest transmission rate among all people living with HIV.[19]

To make strides toward the Presidential Plan to End the HIV Epidemic,[20] we must identify missed opportunities for HIV testing and use these as gateways to treatment and prevention, especially in vulnerable AYAs.[21] Our primary research objective was to examine rates of HIV testing after an incident STI among AYAs in primary care settings and identify patient and health care factors related to receipt of HIV testing, which may serve as targets for future interventions to improve HIV testing.

METHODS

Study Design and Data Source

In this retrospective study, we used electronic health record (EHR) data from 2 urban pediatric/adolescent primary care clinics with high rates of incident STIs and that were affiliated with a large academic health system in Philadelphia.[22] During the observation period, HIV screening was performed only by laboratory-based, fourth-generation antigen-antibody testing. We intentionally limited the observation period to when rapid HIV testing was unavailable because rapid test results were not routinely documented in the EHR, and the barriers to laboratory-based versus rapid HIV testing likely differ. Therefore, the observation period differed between the 2 sites, to reflect when funding for rapid testing was eliminated at these clinics. For site 1, the observation period was July 1, 2014, to December 31, 2017. For site 2, the observation period was January 1, 2015, to December 31, 2017. Data were automatically abstracted from the EHR, initially for quality improvement measurement, by using a commercial business intelligence platform (Qlik, Radnor, PA), which generated a data set of all STI and HIV screening episodes. The final analytic data set contained all visits with an incident STI episode and all follow-up visits within 90 days of that episode. If a patient tested positive for HIV, they were removed from the cohort after diagnosis. In cases of missing data, we performed EHR abstraction. This project was approved by the Institutional Review Boards of the Children's Hospital of Philadelphia and Access Matters.

Study Participants and Setting

Participants were included if they were 13 to 24 years old and had an incident STI episode in the study period. Incident STI episodes were defined as a new diagnosis of *Chlamydia* (*Chlamydia trachomatis)* or gonorrhea (*Neisseria gonorrhea*) via urine, rectal, oral, or cervical nucleic acid amplification tests; trichomoniasis (*Trichomonas vaginalis*) via nucleic acid amplification test or wet mount microscopy; and/or syphilis (*Treponema pallidum*) by serum rapid plasmin reagin testing.

Patients at both sites are mostly African American (87%) and Medicaid insured (79%).[22] Each clinical site has a co-located primary care practice and Title X–funded adolescent program that provides confidential sexual health (family planning) services irrespective of insurance coverage. Primary care patients may receive sexual health services through either primary care or family planning. Uninsured patients or those not enrolled in primary care at the sites receive sexual health services solely in the Title X family planning program. The EHR for family planning visits has additional confidentiality protections, and no billing statements are sent to parents or guardians for these visits. Both sites have similar patient demographics; however, site 1 has larger patient volume and has more adolescent-trained providers.

Outcome Measure

The primary outcome measure was receipt of an HIV test within 90 days of STI diagnosis. This 90-day limit was chosen because this time frame is sufficient for providers to obtain the STI result, communicate it to the patient, invite the patient to return for HIV testing, and have patients complete HIV testing. HIV testing was defined as having a laboratory-based fourth-generation HIV antibody-antigen test. Visits were excluded if

an encounter was not conducive to an HIV test being performed (eg, clinic visits for behavioral health only, immunization visits). For visits when HIV testing was ordered and not completed, we manually reviewed the EHR to ascertain reason for test noncompletion.

Covariates

Patient- and health care–level factors were collected. Patient factors included age, sex, multipathogen STI diagnosis, and previous STIs. Age was categorized as younger (13–17 years old) and older adolescents (18–24 years old) because we hypothesized older adolescents could be more likely to receive testing. Health care factors included adolescent medicine (AM) training of provider (yes or no), insurance status (insured or uninsured), visit type (family planning or primary care), and patient enrollment in primary care at the sites during the study time. Providers were considered AM trained if they were a physician who was enrolled in or had completed AM fellowship or if they were a nurse practitioner assigned to specifically see adolescent family planning patients.

Statistical Analysis

Descriptive statistics summarized characteristics of participants and STI episodes across HIV test outcome. We determined prevalence of HIV testing by calculating the proportion of completed HIV tests within 90 days of the STI episode among all STI episodes. We conducted bivariate analyses using t and χ^2 tests to measure associations between characteristics of STI episodes and HIV test completion.

To examine adjusted associations between patient and health care factors on HIV test completion, we used mixed effects logistic regression models. Odds ratios were estimated, accounting for random effects of subjects and clinic sites.

We first conducted models assessing associations between patient factors and, separately, health care factors on HIV testing. The final multivariable model contained both patient and health care factors because it has been suggested in previous literature that HIV testing may be influenced by all of these variables. We included an interaction term between insurance and family planning visit because we hypothesized that family planning visits could function differently for insured and uninsured patients. Insured patients may opt for family planning visits for confidentiality reasons.

In a sensitivity analysis, we examined if time since last HIV testing had an effect on HIV test completion with incident STI diagnosis. This analysis was performed on a subset of the episodes, from January 2016 to December 2017, to allow for record review of at least 1 full year before each patient's STI episode. We categorized time from last HIV test into 3 groups: those who had an HIV test in the past year, those who had an HIV test more than a year ago, or those with no previous documented HIV test. We performed similar multivariable models as defined above and added the time since last HIV testing variable in 2 ways: categorical and continuous, denoting time in months.

All statistical analyses were done by using Stata 15 (StataCorp LLC, College Station, TX) and SAS 9.4 (SAS Institute, Inc, Cary, NC).

TABLE 1 Patient and Health Care Characteristics of STI Episodes by HIV Test Completion, 2014–2017

	All (n = 1816)	Completed HIV Test (n = 1001)	No HIV Test (n = 815)	P
Age in y, mean (SD)	17.2 (1.7)	17.1 (1.6)	17.3 (1.7)	.04
Sex, *n* (%)				
Female	1356 (74.7)	703 (51.8)	653 (48.7)	<.001
Male	460 (25.3)	298 (64.8)	162 (35.2)	—
Race, *n* (%)				
African American	1766 (97.2)	979 (55.1)	787 (44.6)	.11
Other	50 (2.8)	22 (44.0)	28 (56.0)	—
Hispanic	25 (1.4)	5 (20.0)	20 (80.0)	<.001
Insurance, *n* (%)				
Government	1101 (60.6)	620 (56.3)	481 (43.7)	.06
Private	422 (23.2)	238 (56.4)	184 (43.6)	—
None	293 (16.1)	143 (48.8)	150 (51.2)	—
STI diagnosis, *n* (%)				
Chlamydia	1533 (84.4)	857 (55.9)	676 (44.1)	.28
Gonorrhea	307 (16.9)	178 (58.0)	129 (42.0)	.30
Trichomoniasis	134 (7.4)	57 (42.5)	77 (57.5)	.08
Syphilis	8 (0.4)	8 (100.0)	0 (0.0)	.91
Multipathogen STI, *n* (%)	162 (8.9)	99 (61.1)	63 (38.9)	.11
STI history, *n* (%)				
No previous STIs	1239 (68.2)	735 (59.3)	504 (40.7)	<.001
Previous STIs	577 (31.8)	266 (46.1)	311 (53.9)	—
Mean No. STI (SD)	1.5 (0.86)	1.4 (0.80)	1.6 (0.93)	<.001
AM trained, *n* (%)				
Yes	1022 (56.3)	544 (53.2)	478 (46.8)	.07
No	794 (43.7)	457 (57.6)	337 (42.4)	—
Family planning visit, *n* (%)				
Yes	1489 (82.0)	770 (51.7)	719 (48.3)	<.001
No	327 (18.0)	231 (70.6)	96 (29.4)	—
Visit site[a], *n* (%)				
Site No.1	747 (41.3)	350 (46.9)	397 (53.1)	<.001
Site No. 2	1060 (58.7)	636 (60.0)	424 (40.0)	—

Statistical significance: $P = .05$. All analysis was done in episode level by using t and χ^2 tests and presented by frequency (percentage) or mean (SD). —, not applicable.

[a] Denominator is 1807 because of missing data.

RESULTS

Out of the 16 392 STI tests performed during our study period, 1816 (11.1%) were positive results and were included in our study. These 1816 episodes occurred in 1313 unique individuals. The majority of patients (97.4%) were African American, reflecting the demographics of the clinics. The patients were 70.8% female and 1.4% Hispanic, with a median age of 17 (interquartile range: 16–18). Twenty-seven percent of individuals had multiple STI episodes during the study period. Table 1 shows characteristics of the STI episodes by HIV test completion. The most prevalent STI was *Chlamydia*, followed by gonorrhea, trichomoniasis, and syphilis (Table 1).

Table 1 also shows bivariate associations between patient and health care factors and HIV test completion within 90 days of an STI diagnosis. The proportion of episodes in which HIV testing was completed within 90 days of STI diagnosis was 55.1% (n = 1001 out of 1816 episodes). There was 1 confirmed positive HIV result (0.1%) among completed tests. Figure 1 shows STI episodes and whether HIV testing was ordered and/or performed at baseline and/or follow-up visits. Of those episodes in which HIV testing did not happen concurrent with STI testing, approximately three-quarters had a follow-up visit, of which the majority did not have completed HIV testing. The majority of episodes with completed HIV testing had HIV testing concurrent with STI testing. Of the 815 STI episodes in which HIV testing was not completed, 219 (26.9%) had a test ordered by the provider and not completed by the patient. The main reasons for HIV test noncompletion included patients leaving the laboratory before the test could be performed (n = 146, 66.7%), followed by not showing up at all (n = 40, 18.3%), errors in the medical record or laboratory (n = 10, 4.6%),

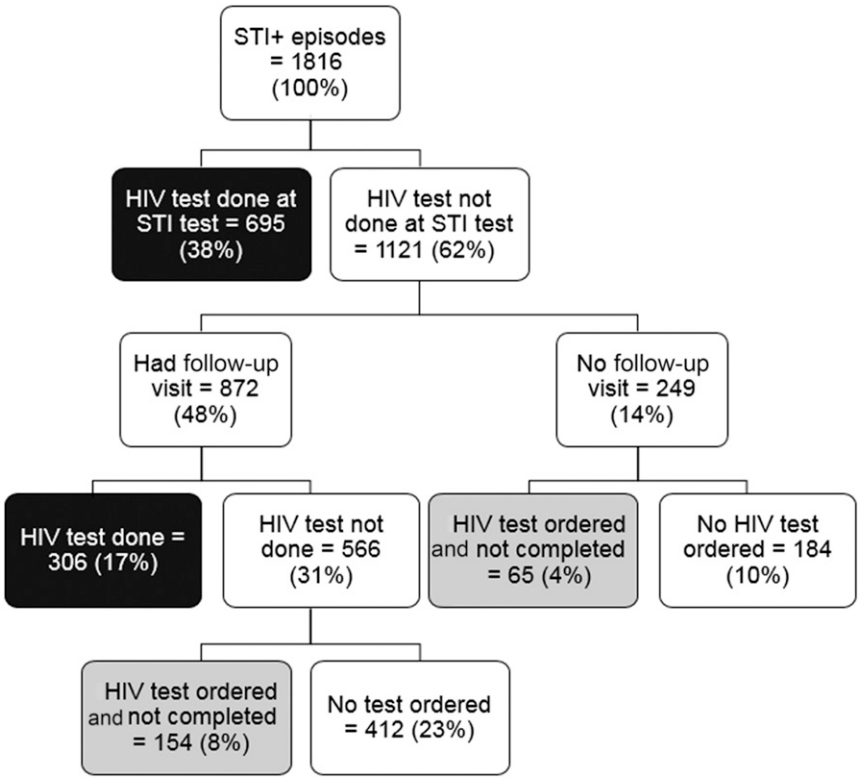

FIGURE 1
Receipt of HIV testing in the study sample by STI episode (n = 1816). Black denotes that HIV test was completed; gray denotes that HIV test was ordered and not completed.

patients declining HIV testing, and closed laboratory (n = 8, 3.6%). Fifteen (6.8%) had no reason listed for HIV test noncompletion.

The results of the 3 mixed effects logistic regression models examining associations between patient and health care characteristics and adjusted odds of HIV test completion are displayed in Table 2. With respect to patient characteristics, females and participants with a previous history of STIs had significantly lower adjusted odds of HIV test completion compared with males and those with no previous history of STIs, respectively. For the health care factors model (Table 2), we found not having insurance and having a family planning visit were both associated with decreased odds of HIV testing compared with their counterparts. There was no significant association between AM training, enrollment in primary care, or the interaction between insurance and family planning and the odds of HIV test completion.

In our final model (Table 2), factors associated with increased odds of completed HIV testing included multipathogen infection at STI diagnosis and enrollment in primary care. Factors associated with decreased odds of HIV testing included having history of previous STIs, being female, uninsured, and having the incident STI diagnosed at a family planning visit.

In the sensitivity analysis (Table 3) examining time from last HIV test with receipt of HIV testing within 90 days of incident STI, participants who had a previous completed HIV test over one year ago or never had a documented HIV test had higher adjusted odds of receipt of HIV testing at incident STI, compared with those with HIV testing within the year before incident STI. Among those

TABLE 2 Mixed Effects Logistic Regression Model Assessing Patient, Health Care, and Combined Factors and the Adjusted Odds of HIV Test Completion

Covariates	Patient Model		Health Care Model		Final Combined Model	
	aOR (95% CI)	*P*	aOR (95% CI)	*P*	aOR (95% CI)	*P*
STIs at diagnosis						
Having 1 STI at diagnosis	Reference	—	—	—	Reference	
Multiple STIs at diagnosis	1.40 (0.99–2.00)	.06	—	—	1.43 (1.00–2.04)	.05
STI history						
No previous history of STIs	Reference	—	—	—	Reference	—
Previous STI history	0.59 (0.47–0.73)	<.001	—	—	0.58 (0.47–0.73)	<.001
Younger versus older adolescents						
13–17 y old	Reference	—	—	—	Reference	—
18–24 y old	0.88 (0.72–1.09)	.24	—	—	0.91 (0.74–1.12)	.58
Patient sex						
Male	Reference	—	—	—	Reference	—
Female	0.63 (0.49–0.80)	<.001	—	—	0.63 (0.49–0.81)	<.001
Adolescent-trained providers						
No	—	—	Reference	—	Reference	—
Yes	—	—	1.00 (0.81–1.24)	.99	1.11 (0.89–1.37)	.36
Insurance status						
Private or government	—	—	Reference	—	Reference	—
No insurance	—	—	0.44 (0.21–0.92)	.03	0.48 (0.23–0.99)	.05
Family planning visit						
No	—	—	Reference	—	Reference	—
Yes	—	—	0.48 (0.34–0.67)	<.001	0.55 (0.39–0.76)	<.001
Interaction (insurance and family planning visit)	—	—	1.87 (0.85–4.14)	.121	1.72 (0.78–3.77)	.18
Primary care enrollment						
No	—	—	Reference	—	Reference	—
Yes	—	—	1.24 (0.90–1.70)	.185	1.46 (1.06–2.01)	.02

A mixed effects logistic regression model was used including all variables above after considering hierarchical structure of STI-related visits by clinic and individual. aOR, adjusted odds ratio; —, not applicable.

with a previous HIV test, there was 8% (odds ratio = 1.08, 95% confidence interval [CI]: 1.04–1.12) increased odds of being appropriately HIV tested within 90 days of STI diagnosis with each additional month since the last documented HIV test.

DISCUSSION

In our sample of adolescents who tested positive for STIs and who were receiving care at large urban primary care clinics, we found that only 55% of incident STI episodes had HIV testing completed within 90 days after STI diagnosis. In previous studies, researchers have found adolescents to be underscreened for HIV, especially in primary care.[13,23] We have expanded on previous work by showing that when adolescents are at highest risk for HIV (ie, diagnosed with an incident STI), only half of STI episodes were appropriately HIV tested. Most completed HIV tests were done at the time of STI testing as a part of sexual health screenings. Promoting the inclusion of HIV testing in comprehensive sexual health screening for adolescents may improve the rates of HIV testing overall. Leaving or not showing up to the laboratory for blood draw were the main reasons for cancelled HIV tests. This suggests that even when a provider orders a laboratory-based HIV test, additional barriers prevent adolescent test completion. Focusing on rapid HIV testing in primary care for adolescents would likely reduce barriers to patients and increase HIV test completion rates.

Clinicians appropriately identified increased HIV risk in cases of multipathogen STIs because these episodes had higher odds of HIV testing. However, they did not appropriately identify increased lifetime HIV risk in patients with previous STIs, who had lower odds of HIV testing than those without a history of STIs. This suggests a significant missed opportunity for targeted HIV screening, early HIV diagnosis, and linkage to HIV care if individuals were HIV positive or initiation of pre-exposure prophylaxis (PrEP) if HIV negative. This finding adds significantly to the literature because little is known about how previous STIs may influence HIV testing in adolescents with acute STIs.[6,7] Youth with previous STIs may paradoxically have a lower perceived HIV risk, given that they have had STIs previously and ostensibly remained HIV negative. Conversely, youth with no previous STI may experience a heightened fear of HIV infection. Finally, patients with previous STIs may have undergone HIV testing concurrent with previous STI diagnoses, thus biasing providers against the need for repeat HIV testing. In this clinical cohort, a single HIV infection was detected within 90 days of STI diagnosis. Because many of the highest-risk youth did not receive testing, the number of

TABLE 3 Sensitivity Analysis: Mixed Effects Logistic Regression Model Assessing Time Since Last HIV Testing, Adjusting for Patient, Health Care, and Combined Factors and the Odds of HIV Test Completion, 2016–2017

Covariates	aOR (95% CI)	*P*
Last HIV test		
Tested <1 y ago	Reference	—
>1 y ago	2.47 (1.50–4.07)	<.001
No documented HIV test	2.10 (1.38–3.20)	.001
STIs at diagnosis		
Having 1 STI at diagnosis	Reference	—
Multiple STIs at diagnosis	1.65 (0.96–2.83)	.07
STI history		
No previous history of STIs	Reference	—
Previous STI history	0.86 (0.61–1.22)	.41
Younger versus older adolescents		
13–17 y old	Reference	—
18–24 y old	0.87 (0.64–1.19)	.39
Patient sex		
Male	Reference	—
Female	0.80 (0.56–1.13)	.21
Adolescent-trained providers		
No	Reference	—
Yes	1.20 (0.87–1.65)	.26
Insurance status		
Private or government	Reference	—
No insurance	0.60 (0.19–1.87)	.38
Family planning visit		
No	Reference	—
Yes	0.47 (0.30–0.75)	.001
Interaction (insurance and family planning visit)	1.45 (0.42–4.92)	.55
Primary care enrollment		
No	Reference	—
Yes	1.76 (1.06–2.92)	.03

A mixed effects logistic regression model was used including all variables above after considering hierarchical structure of STI-related visits by clinic and individual. aOR, adjusted odds ratio; —, not applicable.

missed HIV infections and missed opportunities for linkage to PrEP among high-risk youth who were HIV negative in a high HIV–incidence urban area remain unknown.

Our sensitivity analysis demonstrated that youth who had an HIV test over one year ago or those never tested at these clinics had higher odds of receipt of HIV testing with incident STI. This finding demonstrates that providers may be biased toward testing on a yearly basis, rather than recognizing incident STIs as a biomarker of risk and testing appropriately with each new episode. Although testing guidelines for HIV state that those who are sexually active or those with an STI should be tested for HIV, they do not state that HIV testing should be done solely yearly. To increase HIV testing in those with STIs, health systems should examine strategies for identifying patients with STIs through the EHR and alerting providers on the need for intervention to close this gap in HIV testing. Furthermore, our findings suggest a need for further provider education and guideline clarification because each new STI diagnosis represents an increased temporal risk for HIV and a unique opportunity to link youth who are HIV negative to PrEP when motivation for behavior change may be highest.

Our finding of lower odds of HIV testing in those without insurance is in accordance with previous literature showing reduced HIV testing rates in uninsured individuals.[24–27] Because our patients could receive HIV and STI testing and treatment confidentially, without insurance, and without being capitated to primary care at the site, many of the traditionally identified barriers to HIV testing were mitigated at the study sites. Unexpectedly, having a family planning visit was associated with lower odds of HIV testing, and being enrolled in primary care at the clinics was associated with higher odds of HIV testing. These findings emphasize the importance of receiving primary preventive health care and having an ongoing relationship to clinical sites in receipt of adolescent sexual health care. The literature has shown primary care to be an effective delivery site for adolescent sexual and mental health services.[28–32] Clinicians in sexual health clinics should consider how to connect their patients to primary care to improve ongoing sexual health and HIV testing outcomes.

This study is subject to limitations. Because of the nature of our secondary data, there is the possibility of unmeasured confounders that would have further enriched our investigation (eg, patient sexual orientation, sexual behavior, and additional provider characteristics). Despite this, our sample size was robust, and missing data were marginal or nonexistent for measured variables. Second, patients could have received care from other facilities and health systems outside these sites, making it possible that we did not capture the patients' complete HIV testing histories. However, we believe this is unlikely because both study clinics offered free HIV screening and sexual health services. Therefore, this would limit bias on the basis of insurance status or cost of care. Third, our analysis was limited to a specific section of Philadelphia and may not be generalizable outside of that area. However, Philadelphia STI rates are almost 3 times the national average, and the urban area where the research was conducted has some of the highest rates in

Philadelphia.[33,34] Thus, our study represents a sample at particularly high risk for contracting HIV in which testing rates would be expected to be higher than in regions with low HIV and STI prevalence.

CONCLUSIONS

Our findings identified suboptimal rates of HIV testing in adolescents with STIs, with nearly half of episodes not receiving testing within 90 days of STI diagnosis. In addition, we identified that rates of testing were actually lower in participants who were at highest risk of HIV infection, including those with previous history of STIs. In this study, we focused analyses on adolescents in a primary care setting where HIV and STI testing may occur confidentially and without insurance, ameliorating most barriers to testing and thus representing a unique addition to previous HIV testing research. However, we also identified that some adolescents did not receive HIV testing even when ordered by providers, suggesting that rapid HIV testing at the time of encounter may be beneficial to test completion for adolescents and easier to complete for providers. As we enter the fourth decade of the HIV epidemic, it remains clear that missed opportunities for diagnosis have the potential to delay HIV diagnosis and linkage to antiretroviral therapy or PrEP and prevention services, thus increasing the population risk of HIV transmission.[18,35] Our data underscore the need for improved HIV testing education for providers of all levels of training and the need for public health agencies to clearly communicate the need for testing at the time of STI infection to reduce the number of missed opportunities for testing. It is our hope that our findings can be used to target HIV testing interventions in primary care settings.

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ABBREVIATIONS

AM: adolescent medicine
AYA: adolescent and young adult
CI: confidence interval
EHR: electronic health record
PrEP: pre-exposure prophylaxis
STI: sexually transmitted infection

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