ARTICLE

Changes in Human Immunodeficiency Virus Testing Rates Among Urban Adolescents After Introduction of Routine and Rapid Testing

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Objectives: To examine human immunodeficiency virus (HIV) testing rates among adolescents during a 3-year period to determine (1) if the rate of testing increased after publication of national recommendations for routine HIV testing in 2006, and again after the introduction of rapid testing in the clinic in 2007, and (2) factors associated with HIV testing.

Design: Retrospective medical record review.

Setting: Urban hospital-based adolescent primary care clinic.

Participants: Thirteen- to 22-year-old sexually experienced patients who had computerized billing data reflecting testing for sexually transmitted infections, including HIV.

Outcome Measures: Rates of HIV testing for each of 3 one-year phases—phase 1 (pre–routine testing recommendations), phase 2 (post–routine testing recommendations but pre–rapid testing), and phase 3 (post–rapid testing)—and factors associated with HIV testing.

Results: In total, 9491 patients were included. The rate of HIV testing in phase 2 was significantly higher than the rate of testing in phase 1 (27.7% vs 12.6%, $P<.001$). The rate of testing in phase 3 was significantly higher than the rate of testing in phase 2 (44.6% vs 27.7%, $P<.001$) and phase 1 ($P<.001$). Factors independently associated with HIV testing included phase, older age, male sex, race, public insurance status, and having a genitourinary-related diagnosis during the same phase.

Conclusions: The HIV testing rates increased significantly following publication of recommendations for routine testing and further increased following introduction of rapid testing. Combining routine and rapid testing strategies may increase uptake of HIV testing among adolescents in primary care settings.

Arch Pediatr Adolesc Med. 2010;164(9):870-874

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According to estimates from the Centers for Disease Control and Prevention (CDC), more than 56 000 new human immunodeficiency virus (HIV) infections occur in the United States annually.[1] In 2006, 34% of new HIV infections were diagnosed in adolescents and young adults aged 13 to 29 years.[1] An estimated 47.8% of HIV-infected youth aged 13 to 24 years in the United States are unaware of their serostatus.[2] In an effort to increase serostatus awareness, in 2006 the CDC released their current recommendations for routine HIV testing of all adults and adolescents aged 13 to 64 years.[3] These recommendations also include screening all persons presenting for evaluation of sexually transmitted infections (STIs) and at least annual screening of high-risk individuals, such as those who have had multiple sexual partners (or whose partner[s] have had multiple sexual partners) since their most recent HIV test.[3] Studies of routine HIV testing in both adults and adolescents have been performed in emergency department and urgent care settings.[4-9] However, because the CDC recommends routine testing of adolescents in all medical settings, studies are needed to examine the impact of these recommendations in other settings, including primary care clinics.

In addition to routine testing, rapid HIV testing has been proposed as another intervention to improve testing rates and serostatus awareness. Traditional enzyme immunoassay (EIA) HIV tests may require venipuncture sampling; patients receive their results 1 to 2 weeks after sample collection. Although EIA HIV tests may be performed with oral fluid samples, this is not widely available. Rapid HIV tests, like traditional EIA tests, assess for HIV antibodies. Rapid HIV tests require less invasive sampling (fingerstick whole blood or oral fluid) than traditional tests, and results are available soon after sample collection. Introduction of rapid testing has been associated with increased uptake of HIV testing among adults,[10] and when offered a choice of testing methods, adults preferred rapid testing.[11-13] In other studies, ado-

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lescents preferred rapid HIV tests because results are obtained rapidly[14] and sampling is less invasive.[14,15] Adolescents also preferred rapid testing to traditional testing when routinely offered a choice of method.[15] To our knowledge, no studies to date have demonstrated that offering rapid HIV testing in a primary care setting leads to improved rates of testing among adolescents.

Although the CDC recommends routine HIV testing of all adolescents, the current study focused on the effect of these recommendations on routine screening of sexually experienced adolescents, because these youth are at higher risk of HIV infection. The objective of this study was to examine changes in rates of HIV testing among sexually experienced adolescents in a primary care setting after publication of the CDC recommendations for HIV testing in 2006 and after introduction of rapid testing in that setting in 2007. The primary aim was to determine whether rates of HIV testing increased following the CDC recommendation for routine testing and whether rates of HIV testing further increased following introduction of rapid (oral fluid or fingerstick whole blood) testing in this clinic setting. The secondary aim was to determine what factors were independently associated with HIV testing.

METHODS

Computerized billing data from an urban, hospital-based outpatient adolescent clinic were examined retrospectively. Records for patients younger than 13 years or 23 years or older at the time of the clinic visit were excluded. Data were included for encounters that occurred during any of 3 time phases, which were defined based on the date of release of the CDC recommendations for routine testing and implementation of rapid oral and fingerstick whole blood testing in the clinic. Phase 1 (pre–CDC recommendations) included data from September 23, 2005, to September 22, 2006. Phase 2 (post–CDC recommendations but pre–rapid testing) included data from November 2, 2006, to November 1, 2007. Phase 3 (post–rapid testing) included data from November 2, 2007, to November 1, 2008. An approximately 6-week period between phase 1 and phase 2 was not included, because during that time, CDC recommendations were being disseminated and providers were presumably becoming familiar with the new recommendations and incorporating them into practice. There were no formal educational interventions with providers. Written informed consent with pretest counseling was required for all HIV testing throughout the study period. The study received approval from the hospital's institutional review board.

Because the focus of this study was HIV testing among sexually experienced adolescents, only patients who had laboratory billing records reflecting *Neisseria gonorrhoeae* and/or *Chlamydia trachomatis* testing at any visit during any phase were included in the study. *N gonorrhoeae* and/or *C trachomatis* testing was used as a marker of sexual activity because sexually experienced adolescents in this clinic are routinely screened for these infections every 6 to 12 months. Patient laboratory billing records were queried for performance of any HIV test (traditional venipuncture EIA testing or rapid testing with oral fluid or fingerstick whole blood sampling) at any visit during any phase. Nonrapid testing using oral fluid sampling was not available in this clinical setting. To capture point-of-care rapid tests that may not have been billed by providers, the clinic-maintained records for all rapid HIV tests were reviewed manually. For each phase, the rate of HIV testing was defined as the proportion of patients who had STI testing (*N gonorrhoeae* and/or *C trachomatis* testing) and HIV testing at least once during the same 1-year phase among those who had STI testing at least once during that same phase. The same patient was included only once per phase but could be included in multiple phases if he or she was tested for STIs in multiple phases.

Table 1. Sample Characteristics

Variable	Patients, No. (%) (N=9491)
No. of patients	
Phase 1	3002 (31.6)
Phase 2	3213 (33.9)
Phase 3	3276 (34.5)
No. of visits/phase, mean (SD)	1.5 (0.9)
Age, mean (SD), y	17.5 (1.9)
Sex	
F	7800 (82.2)
M	1691 (17.8)
Race/ethnicity	
African American/black	6584 (69.4)
White	2520 (26.6)
Other[a]	387 (4.1)
Insurance status	
Self-pay/none	1966 (20.7)
Public[b]	5486 (57.8)
Commercial	2039 (21.5)
Any genitourinary-related diagnosis during same phase[c]	1112 (11.7)
≥1 HIV test	2727 (28.7)
Phase 1[d]	378 (12.6)
Phase 2[d]	889 (27.7)
Phase 3[d]	1460 (44.6)

Abbreviation: HIV, human immunodeficiency virus.
[a] The "other" category includes Asian (n=10), multiracial (n=116), Hispanic (n=18), and self-identified other (n=243).
[b] For example, Medicaid and state-administered health insurance.
[c] Genitourinary-related diagnoses (*International Classification of Diseases, Ninth Revision* codes) included genital herpes (054.10), genital condyloma (078.11), *Chlamydia trachomatis* (079.88), syphilis (primary syphilis [091.0], secondary syphilis of skin or mucus membranes [091.3], early latent syphilis [092], late latent syphilis [096], latent syphilis, unspecified [097.1], and syphilis unspecified [097.9]), acute gonorrhea (098.0), acute gonococcal epididymitis/orchitis (098.13), chronic gonorrhea (098.2), chronic gonococcal epididymitis/orchitis (098.33), urethritis (099.4), trichomoniasis (131.8), epididymitis/orchitis (604), pelvic inflammatory disease (614.9), cervicitis (616.0), and vaginal discharge (623.5).
[d] Percent reported is for number of patients in each phase separately.

Patient registration and billing data were used to collect data on demographic variables and genitourinary-related diagnoses. Demographic variables were collected from registration data and included birth date, date of visit, race/ethnicity, sex, and insurance status. These variables were selected because they were relevant to the study and available through the electronic registration system. Genitourinary-related diagnoses were assessed using billing data containing primary *International Classification of Diseases, Ninth Revision*, codes (**Table 1**). Owing to the small number of cases for some individual genitourinary-related diagnoses, genitourinary-related diagnosis was dichotomized to reflect presence or absence of a diagnosis for each patient per phase.

Descriptive analyses were performed to examine the total number of patients who had STI testing per phase and the rate of HIV testing per phase, as well as age, race/ethnicity, sex, insurance status, and receipt of any genitourinary-related diagnosis in the phase. For patients with multiple visits during a phase, age at the first visit during the phase was used. χ^2 Analyses were used to compare the rates of HIV testing between the different phases. A 1-sample χ^2 test was used to examine the proportion of HIV tests performed in phase 3 that were rapid vs traditional tests.

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Table 2. Results of Unadjusted and Adjusted Logistic Regression Models of HIV Testing

Variable	OR (95% CI)	
	Unadjusted[a]	Adjusted[b]
Phase 2 vs phase 1	2.66 (2.33-3.03)[c]	2.71 (2.36-3.10)[c]
Phase 3 vs phase 1	5.58 (4.91-6.34)[c]	5.57 (4.88-6.36)[c]
Age, continuous, y	1.03 (1.01-1.06)[c]	1.06 (1.03-1.09)[c]
Male vs female sex	1.83 (1.64-2.04)[c]	1.93 (1.71-2.18)[c]
Race		
African American/black vs white	2.55 (2.27-2.87)[c]	1.96 (1.72-2.23)[c]
Other vs white	1.88 (1.47-2.41)[c]	1.60 (1.23-2.08)[c]
Insurance		
Public vs self-pay/none	1.23 (1.09-1.37)[c]	1.30 (1.15-1.48)[c]
Commercial vs self-pay/none	0.65 (0.57-0.76)[c]	0.91 (0.77-1.07)
Any genitourinary-related diagnosis in phase	2.78 (2.44-3.15)[c]	2.87 (2.50-3.30)[c]

Abbreviations: CI, confidence interval; HIV, human immunodeficiency virus; OR, odds ratio.

[a] Odds ratios presented are significant at $P<.10$ and were entered into the adjusted logistic regression model.

[b] The model is adjusted for all the variables listed in the first column.

[c] Significant at $P<.05$.

Unadjusted univariable logistic regression was used to assess associations between predictor variables (phase, age, sex, race/ethnicity, insurance status, and receipt of any genitourinary-related diagnosis in the phase) and HIV testing in each phase. Predictor variables with $P<.10$ were included in a multivariable logistic regression model to determine variables that were independently associated with HIV testing in each phase. Forward and backward stepwise logistic regression modeling was performed to obtain the most stable model.

RESULTS

For all phases combined, 9491 patients had STI testing: 3002 patients (31.6%) in phase 1, 3213 (33.9%) in phase 2, and 3276 (34.5%) in phase 3. The mean age was 17.5 years. Most patients were female (82.2%) and African American/black (69.4%) (Table 1). More than 11% of the patients had at least 1 genitourinary-related diagnosis during the phase (2.6% of males vs 13.7% of females, $P<.001$).

A total of 2727 patients (28.7%) were tested for HIV during the study period: 378 in phase 1 (12.6% of patients in phase 1), 889 in phase 2 (27.7% of patients in phase 2), and 1460 in phase 3 (44.6% of patients in phase 3). The rate of HIV testing in phase 2 was significantly higher than phase 1 ($P<.001$). The rate of HIV testing in phase 3 was significantly higher than phase 2 ($P<.001$) and phase 1 ($P<.001$). Of 1591 HIV tests that were performed in phase 3, there were significantly more rapid tests than traditional EIA tests (53.1% vs 46.9%, $P=.01$).

Univariable analyses demonstrated that multiple factors were associated with HIV testing during each phase (**Table 2**). Patients in phases 2 and 3 had higher odds of testing compared with patients in phase 1. Older age, male sex, African American/black race (vs white), other race/ethnicity (vs white), and having a genitourinary-related diagnosis were associated with HIV testing during the same phase. Patients with public insurance had increased odds of having an HIV test compared with those with no insurance, and patients with commercial insurance had decreased odds of testing compared with those with no insurance. Race/ethnicity and insurance status were significantly associated with each other: a higher proportion of white patients had commercial insurance, and a higher proportion of African American/black patients had public insurance ($P<.001$). Stratified analyses by sex demonstrated that genitourinary-related diagnosis during the phase was associated with HIV testing in both girls and boys ($P<.001$ for both).

Multivariable logistic regression models demonstrated that older age, phase, male sex, public insurance status, race/ethnicity, and having any genitourinary-related diagnosis were independently associated with HIV testing during the same phase (Table 2). Patients in phase 2 had 2.71 times and patients in phase 3 had 5.57 times the odds of having an HIV test during the same phase compared with patients in phase 1. Males had 1.93 times the odds of having an HIV test in each phase compared with females. Patients with public insurance had 1.3 times the odds of having an HIV test during each phase compared with patients with no insurance. Those of African American/black and other race/ethnicity had increased odds of having an HIV test during each phase compared with white individuals (odds ratio, 1.96 and 1.60, respectively). Patients with any genitourinary-related diagnosis had 2.87 times the odds of having an HIV test during the same phase compared with patients who had no genitourinary-related diagnosis. Additional multivariable analyses demonstrated a significant interaction between race and insurance status ($P<.001$), implying that insurance status moderated the association between race and HIV testing.

COMMENT

We examined rates of HIV testing among sexually experienced adolescents receiving care in an urban primary care clinic across 3 consecutive 1-year phases coinciding with changes in both national and local HIV testing strategies. This study is unique because we separately examined (1) changes in HIV testing rates that occurred after the release of the 2006 CDC recommendations for routine testing and (2) changes in rates of testing after both rapid and traditional testing was available in the clinic.

In this study, HIV testing rates increased significantly following the release of the CDC recommendations for routine testing. Studies of routine HIV testing programs in adult emergency departments and urgent care centers have shown testing acceptance rates of 37.3% to 53%.[4-7,9] A slightly higher acceptance rate (58%) was achieved with routine testing in a rural community health center.[16] Among adolescents, 49% to 61% of patients seeking care in emergency departments accepted routine, oral nonrapid HIV testing.[6,8] The overall rate of testing after the CDC recommendations were published was somewhat lower in the current study (27.7%), which may be due to gradual provider uptake of the recommendations for routine testing. This lower rate of testing may also be related to the low rate of testing at baseline (12.6%), which could be due to a perception among providers that HIV infection is uncommon among adolescents in this midwestern city (Cin-

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cinnati). In prior studies of routine testing among adolescents, oral fluid sampling for nonrapid HIV tests was offered. In the current study, only venipuncture nonrapid testing was available during the 1-year period following the release of the CDC recommendations. Thus, our lower rate of testing may be related to patient reluctance to undergo venipuncture testing, as suggested by the increase in testing rates following implementation of rapid oral and fingerstick whole blood testing.

In the year after rapid HIV testing methods were introduced in this clinical setting, the rate of HIV testing significantly increased beyond the rate achieved when only traditional venipuncture testing was offered. In prior studies, including one done with the same clinic population as the current study, adolescents preferred both less invasive sampling and rapid return of results,[14,15,17] which may explain the significant increase in our testing rate following introduction of a rapid testing method that uses less invasive sampling. Significantly more rapid tests were performed in phase 3 than traditional tests, which may reflect adolescents' preference for rapid testing or may be related to providers being more likely to offer a new testing method. The proportion of traditional tests in phase 3 (46.9%) was higher than in our previous study (30%), which had included patients recruited from the same clinic population but was completed prior to introduction of rapid testing into the clinic.[15] A portion of the traditional venipuncture tests may have been performed in the context of other clinically indicated blood work, and thus the patient may have chosen a traditional test because he or she was already undergoing venipuncture. Because our database only contained data for *N gonorrhoeae*, *C trachomatis*, and HIV testing, we cannot draw any definitive conclusions about a relationship between venipuncture testing and other clinically indicated blood work. Additionally, provider preference for a particular HIV test may influence adolescent selection of a testing method, similar to the findings of a study of physician colon cancer screening practices.[18]

Genitourinary-related diagnosis (including specific STIs and STI syndromes) was independently associated with HIV testing during the same phase. Our findings are consistent with another study of adolescents in primary care and outreach settings in whom an STI diagnosis at baseline was associated with HIV testing during the subsequent 3 months.[19] However, among commercially insured patients, STI diagnosis was not associated with HIV testing.[20] In the current study, patients who received any genitourinary-related diagnosis had higher odds of being tested for HIV during the same phase; this was true for both sexes, despite the fact that fewer males than females had genitourinary-related diagnoses. As demonstrated by the multivariable model, the association between genitourinary-related diagnosis and HIV testing during the same phase persisted when controlling for phase. The association between genitourinary-related diagnosis and HIV testing may be due to the current CDC recommendations for HIV testing of all patients who present for treatment of STI-related complaints. However, this association may also reflect higher acceptance rates of HIV testing among patients receiving a genitourinary-related diagnosis. Further investigation is needed to determine whether providers were offering HIV testing more often to patients who received genitourinary-related diagnoses or whether patients who received genitourinary-related diagnoses were more likely to accept testing compared with those who did not have a genitourinary-related diagnosis.

Several demographic factors were independently associated with HIV testing during the same phase. Older age was independently associated with testing. Older patients may have better personal risk assessment or may be more aware of HIV in their community. Clinicians may also be more likely to recommend HIV testing to older patients who may have accrued more lifetime sexual partners than younger patients. Male sex was independently associated with testing, though the sample was only 18% male. This finding is consistent with a previous study of this population of adolescents in which males had higher odds of accepting routine testing than females.[21] However, this finding is in contrast to another study of adolescent HIV testing in which females were more likely to report a history of testing. The sex difference in testing rates in that study was at least partly explained by pregnancy-associated testing among the females.[22] In the current study, race/ethnicity was significantly associated with testing, such that those of African American/black and other race/ethnicities had higher odds of having been tested compared with white individuals. The association between race and testing may be explained in part by the significant association between race and insurance status. In this sample, insurance status moderated the relationship between race and HIV testing. Another possible explanation of the association between race and testing may be that providers or patients may be aware of the racial disparities in new HIV infections. Thus, providers may be more likely to offer testing to minority patients and minority patients may be more likely to accept HIV testing compared with white patients. The lower rate of testing among patients with commercial insurance may be due to patient concerns about possible breach of confidentiality if a parent is billed for the patient's HIV testing.

This study is subject to several limitations. First, the laboratory billing data may have been incomplete and thus underestimated the number of sexually active youth. However, laboratory-based billing data may be less prone to missing data than medical provider–based billing data. Second, only the primary diagnosis was available for examining genitourinary-related diagnoses; therefore, other patients may have received a genitourinary-related diagnosis that was not the primary code and thus would not have been included among those who had received a genitourinary-related diagnosis. However, despite potentially missing some genitourinary-related diagnoses, we found a significant association between receiving a genitourinary-related diagnosis and HIV testing during the same phase. We could not examine the association between HIV testing and each individual genitourinary-related diagnosis owing to the relatively small number of patients with some diagnoses. Third, this is a study of 1 medical clinic and includes only patients who have access to medical care, which may limit the generalizability of our findings. Fourth, we were unable to track the number of patients who were offered but declined HIV testing. We expect that the proportion of refusals of HIV testing would be fairly constant across the latter 2 phases, if the refusal was not related to test characteristics such as method of sampling or time to results.

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Fifth, we may have underestimated the rate of testing in this clinic, as adolescents who were not tested for STIs (including those who were never sexually active) would not have been included in this sample. Alternatively, some patients may have been inappropriately tested for HIV, such as those in mutually monogamous relationships in which both partners have had previous HIV testing. In addition, some patients included in the study may have received HIV testing and STI testing separately and thus may not have warranted HIV testing in the same phase as their STI testing. The increases in rates of testing following implementation of rapid testing may be related to other factors, such as improved provider compliance with the recommendations for routine testing. Lastly, because this study was designed to evaluate changes in overall rates of HIV testing and not changes in rates of positive HIV test results, it does not provide any insight into whether increased HIV screening in this setting led to increased identification of HIV-infected individuals and subsequent linkage to care.

This study has several strengths. The patients included in this study were seeking care at a primary care adolescent clinic, which is important because the CDC currently recommends routine HIV testing of all adolescents being seen in medical settings. This study also separately assessed rates of testing after the release of the CDC recommendations for routine testing and after implementation of rapid testing.

Although routine testing may lead to increased uptake of HIV testing, offering adolescents their choice of testing methods, including rapid methods, which may be more acceptable, may lead to further uptake of HIV testing in this vulnerable population. The findings also suggest that public health recommendations at a national level may affect youth HIV screening. Additional studies are needed to examine factors associated with refusal to test when a routine testing strategy is used and to examine predictors of routine testing in all adolescents, including those who are not sexually experienced.

Accepted for Publication: February 9, 2010.
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Author Contributions: Dr Mullins had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Mullins, Kollar, and Lehmann. *Acquisition of data:* Mullins. *Analysis and interpretation of data:* Mullins and Kahn. *Drafting of the manuscript:* Mullins, Kollar, and Lehmann. *Critical revision of the manuscript for important intellectual content:* Mullins, Lehmann, and Kahn. *Statistical analysis:* Mullins. *Obtained funding:* Mullins. *Administrative, technical, and material support:* Kollar and Lehmann. *Study supervision:* Kahn.
Financial Disclosure: None reported.
Funding/Support: This project was supported by funds from the Bureau of Health Professions, Health Resources and Services Administration, Department of Health and Human Services, through a National Research Service Award Training grant T32HP10027 (principal investigator, Robert Kahn, MD, MPH).
Disclaimer: The information or content and conclusions are those of the authors and should not be construed as the official position or policy of nor should any endorsements be inferred by the Bureau of Health Professions, Health Resources and Services Administration, Department of Health and Human Services, or the US government.
Additional Contributions: Julie E. Moldt, MHA, and Lisa A. Ulland, MBA, assisted in obtaining the primary data.

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