Published in final edited form as:

J Adolesc Health. 2018 September ; 63(3): 342–347. doi:10.1016/j.jadohealth.2018.04.013.

Sexually Transmitted Infection Testing in Adolescents: Current Practices in the Hospital Setting

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Abstract

Purpose: Adolescents are disproportionately affected by STIs, and evidence supports expanding sexual health services to the hospital setting. Because STI testing practices in the hospital setting are poorly understood, we sought to describe current STI testing practices among adolescents seen in children's hospitals.

Methods: We performed a retrospective analysis of adolescents (14–18 years old) from 45 children's hospitals in 2015–2016, excluding visits with a billing code for sexual abuse/assault. We calculated rates of STI testing and investigated differences in STI testing by patient and hospital characteristics using generalized linear mixed modeling.

Results: Of the 541,714 adolescent encounters, 59,158 (10.9%) underwent STI testing. After adjusting for demographic characteristics, those with an STI test were more likely to be female (aOR 1.61; 95% CI 1.58–1.64), of non-Hispanic black race/ethnicity (aOR 1.20; 95% CI 1.17–1.23), or from the lowest median household income quartile (aOR 1.21; 95% CI 1.17–1.24). There was substantial inter-hospital variation in adjusted rates of STI testing (3%–24%), but strong

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correlation was observed between STI testing rates in the ED and inpatient settings within individual hospitals (adjusted R² 0.99).

Conclusions: Only one in ten adolescents seen in children's hospitals underwent STI testing with wide variation in testing patterns across hospitals. There are critical opportunities to increase adolescent STI testing in this setting. Our findings highlight potential disparities in STI testing rates and patterns that warrant further exploration from the patient, provider and health system perspective.

Keywords

sexual and reproductive health; emergency department; inpatient

Introduction

The detrimental impact of sexually transmitted infections (STIs) on adolescent health is well established. There are an estimated 20 million new STIs diagnosed annually in the United States (US), half of which are diagnosed in patients 15–24 years old.¹ *Chlamydia trachomatis* (CT) and *Neisseria gonorrhoeae* (GC) are the most commonly diagnosed STIs in adolescents. Inadequate or delayed treatment is associated with the development of chronic abdominal pain, pelvic inflammatory disease, ectopic pregnancy, and/or infertility.¹

By promoting healthy reproductive behaviors, pediatricians can play a vital role in ameliorating the impact of STIs on adolescent health.^{2,3} However, despite well-established guidelines for STI testing, pediatric providers do not consistently perform STI testing when indicated.⁴ For instance, in a study of outpatient practices, only 46% of pediatricians reported STI screening for all sexually active adolescents, and only 28% reported screening for human immunodeficiency virus (HIV). Respondents cited multiple barriers, including lack of time or desire to provide thorough, confidential, and comprehensive sexual health care for adolescents.^{4,5} Additionally, adolescents may not routinely seek preventive care, and tend to rely heavily on the acute healthcare setting for medical concerns, where comprehensive preventive care is not standard.⁶

One strategy to overcome these barriers is expansion of preventive services such as STI testing to the hospital setting. While studies have demonstrated that adolescents and their parents are open to reproductive preventive care when offered within the hospital, STI testing practices in these clinical settings remain poorly understood.^{7,8,9} Therefore, our primary aim was to describe current STI testing practices for adolescents seen in the pediatric hospital setting. Our secondary aims were to identify patient and hospital-level characteristics that are associated with STI testing and to describe inter- and intra- hospital variation in STI testing.

Methods

Study Design and Setting

We performed a retrospective cohort study utilizing the Pediatric Health Information System (PHIS) database. The PHIS database contains administrative data (demographics, ZIP codes

of residence, diagnosis codes, procedure codes) and billing data (clinical charges) (Appendix 1) on discharges from 49 tertiary care children's hospitals across the US. Data quality is maintained by a joint effort between the Children's Hospital Association (Lenexa, KS), participating hospitals, and Truven Health/IBM Watson Health (Ann Arbor, MI). Due to use of de-identified data, this study was determined to be non-human subject research by the institutional review board at Children's Mercy Kansas City (Kansas City, MO).

Cohort Definition

We identified emergency department (ED), and inpatient/observation encounters for adolescent patients aged 14–18 years who presented to a PHIS hospital from October 1, 2015 through September 30, 2016. Hospitals with incomplete data during the study period were excluded (N=4). Encounters with a diagnosis code indicating sexual abuse or assault were excluded due to different risk factors for STIs and thus different implications for STI testing.^{1,8}

Main Exposures

We assessed patient characteristics, including age, gender, race/ethnicity, insurance type, and ZIP code-based median annual household income quartile (Q) generated from 2010 US census data, (Q1: \$33,311, Q2: \$33,312–41,386, Q3: \$41,387–54,013, Q4: \$54,014). ZIP code-based median household income has been previously demonstrated to be a useful proxy for socioeconomic status (SES) when individual level data are unavailable.¹¹ Hospital-level characteristics included the clinical setting of STI testing (ED or inpatient/observation), and hospital location by region (defined by US Census regions).

Main Outcomes

Our primary outcome was the proportion of encounters during which STI testing was performed. We queried the PHIS database to identify patient encounters with a billing charge for the following STI tests: CT, GC, HIV, *Treponema pallidum* (syphilis) and *Trichomonas vaginalis* (TV). (Appendix 1)

Study Definitions

The clinical setting of an STI test was defined as ED-only if patients were discharged from the ED and inpatient (including observation) for patients directly admitted to the inpatient service. For inpatient encounters admitted through the ED, an STI test was attributed to the ED if the charge for the test occurred on the first day of hospitalization;¹² charges for STI testing that occurred on subsequent days of hospitalization were attributed to the inpatient setting. Billing codes in PHIS did not distinguish testing for CT from testing for GC so we combined GC and CT into a single test (GC/CT). Hospital region was categorized according to the US census regions (e.g., Northeast, South, Midwest, West) because the Centers for Disease Control and Prevention (CDC) describe prevalence of STIs by US census regions.¹

Analysis

Descriptive statistics with frequencies and percentages were used to summarize categorical variables, and medians and interquartile ranges (IQR) were used to summarize continuous

variables. We assessed differences between patient-level and hospital-level characteristics using Wilcoxon rank-sum tests for continuous variables and Chi-square or Fisher's exact test for categorical variables. We used generalized linear mixed modeling techniques to adjust outcomes for patient-level characteristics including age, gender, race/ethnicity, insurance type, and median household income quartile. Statistical models also included a random intercept for each hospital to account for patient clustering of discharges within individual hospitals. We then used linear regression techniques to assess the correlation in adjusted STI testing rates between the inpatient and ED setting. All statistical tests were two-sided, and p-values < 0.05 were considered statistically significant. Statistical analyses were performed using SAS software v 9.4 (SAS Institute, Cary, NC, USA).

Results

Patient-level Characteristics

There were 541,714 adolescent encounters (25% inpatient, 75% ED), of which 59,158 (10.9%) had an STI test performed (Table 1). Among those patients with STI testing, the median age was 16 years, most were female (66%) and more were non-Hispanic black (33%) than any other racial/ethnic group. Most patients who had STI testing had government insurance (62%) and were in the lowest median household income quartile (36%).

Hospital-level Characteristics

There were differences in hospital-level STI testing practices by clinical setting, with more testing performed in the inpatient compared to the ED (unadjusted rates: 13% vs. 10%, respectively). (Appendix 2) We found there was more STI testing performed in the ED in females and those with non-Hispanic black race/ethnicity compared to inpatient. Additionally, we found differences in STI testing according to hospital region; the largest proportion of ED/inpatient encounters with STI testing performed occurred in the South (39%).

Differences in STI Testing by Specific Infection

A majority of patients with an STI test were tested for GC/CT alone (81%) (Table 2). All other STI tests were more frequently performed in combination, although HIV had slightly higher rates of individual testing (20.7% compared to TV (4%), $p < 0.001$ or syphilis (9%), $p < 0.001$).

Adjusted Odds and Probabilities of STI Testing Based upon Patient and Hospital-Level Characteristics

After accounting for patient and hospital-level characteristics, we found that STI testing was more common among females and older patients (adjusted odds ratio [aOR] 1.61; 95% confidence interval [CI] 1.58–1.64 for female vs. male patients, and aOR 2.15; 95% CI 2.08–2.22 for 18 year old vs. aOR 1.22; 95% CI 1.19–1.26 for 15 year old patients) (Table 3). Non-Hispanic blacks, adolescents living in ZIP codes within the lowest quartile of median household income and adolescents with self-pay or government insurance also had increased odds of an STI test (non-Hispanic black race/ethnicity: aOR 1.20; 95% CI 1.17–1.23; lowest median household income: aOR 1.21; 95% CI 1.17–1.24; self-pay insurance

type: aOR 1.33; 95% CI 1.27–1.37, government insurance type: aOR 1.27; 95% CI 1.24–1.30). Patients were more likely to receive STI testing in the inpatient setting compared to the ED setting (aOR 1.60; 95% CI 1.56–1.62) (Table 3). After adjustment there was no difference in odds of STI testing based upon hospital census region. Although the adjusted odds of testing varied greatly by patient and hospital-level characteristics, the adjusted probability of testing was infrequent for all adolescents (Table 3). For instance, the adjusted probability of STI testing in a 14-year-old patient was 8%, and increased to only 16% among 18-year-old adolescents. All other adjusted probabilities were less than 15%.

Inter-hospital Differences in STI Testing

There was marked variation in the adjusted prevalence of STI testing between hospitals (Figure 1). STI testing between hospitals in both clinical settings ranged from 3% to 24%. However, there was strong correlation between STI testing in ED and inpatient settings (adjusted $R^2=0.99$, $p<0.001$) within individual hospitals.

Discussion

In this study of 541,714 adolescent encounters in the hospital setting, we found that STI testing occurred infrequently. However, certain patients were more likely to be tested, including older adolescents, females, and those with a marker of low SES, which is consistent with current literature.^{13,14} Additionally, adolescents who were admitted had a higher probability of receiving STI testing. There was no difference in STI testing based upon the location of a hospital within a census region; however, there was marked variation in testing between individual hospitals and strong correlation in testing prevalence between clinical settings (ED and inpatient).

A major challenge to performing adolescent STI testing according to recommended guidelines is accurately identifying those who are sexually active and at highest risk of contracting an STI. According to the CDC, 34% of high school age teens report being sexually active, which is likely an underestimation due to under reporting.¹⁵ Further, despite recommendations to routinely perform a confidential sexual health history in adolescents,^{2,3} pediatricians are not consistently providing this critical evidence-based care in the ambulatory or hospital-based setting.^{4,16} A recent study in the pediatric hospital demonstrated only 62% of adolescents have a documented sexual history.¹⁶ National guidelines recommend at a minimum: annual GC/CT screening for all sexually active females <25 years of age, HIV testing at least once for ages 13–64 in all health care settings, and additional risk-based screening for high risk populations such as patients with multiple partners, gay and bisexual patients, and men who have sex with men.^{1,17} We found females were more likely to be tested than males. This gender gap in male STI testing is likely due in part to different national recommendations for STI testing in females and males.¹⁷ Additionally, less frequent sexual health assessment,¹⁶ social stigma,¹⁸ lower overall healthcare utilization among young males¹⁹ may further contribute to lower rates of STI testing among males. A recent study of outpatient STI testing patterns demonstrated similarly low testing rates with 11.5% of adolescents reporting STI screening in the past year, and more testing seen in females compared to males.¹⁴

Our study highlights critical missed opportunities for STI testing. In our study, STI testing was performed in only 10.9% (59,158) of ED and inpatient encounters. Assuming 34% of adolescents are sexually active,¹⁵ an additional 125,025 STI tests could have been performed. With prevalence as high as 9.9%,²⁰ an additional 12,377 STIs may have been detected that would have otherwise gone undiagnosed. These findings reveal a critical opportunity to improve adolescent access to STI testing, thus impacting individual health outcomes of adolescents in the hospital setting as well as public health outcomes through improved STI prevalence.

We found more STI testing performed in the inpatient compared to the ED setting even after adjusting for patient age, race/ethnicity, payer and median household income. We expected more STI testing in the ED given that most research has focused heavily on expansion of reproductive care provision in the ED.^{9,20,21} The higher rate of STI testing in inpatient settings may be due to clinical setting differences, such as increased medical complexity of hospitalized patients, more time for diagnostic work up, and greater subspecialty involvement.²²

We observed considerable variation in STI testing between hospitals, with most hospitals testing less than 10% of their adolescents in both the ED and inpatient setting. However, we observed strong correlation between STI testing in the ED and inpatient setting by hospital. Given that regional variation was insignificant in the adjusted model, it appears that the inter-hospital variation is likely driven by hospital-specific factors, such as overall hospital culture or practices, rather than regional factors such as STI prevalence. Potential reasons for such variability include existence of robust adolescent health programs, clinical practice guidelines and/or use of computerized health screening systems to provide automated assistance for care provision. A recent randomized controlled study demonstrated increased STI testing in adolescents, especially among the asymptomatic, with the use of decision support and a computerized sexual health screen.²³ Incorporation of this model for care delivery could improve STI testing and detection, ultimately leading to improved adolescent sexual health outcomes. Further investigation into hospital- and provider-specific cultures, programs, and practices is warranted in order to identify drivers of this wide practice variability and to identify methods for increasing STI testing, particularly at institutions with the lowest testing rates.

Our study should be viewed in light of several limitations. Due to the use of administrative data, we relied on accuracy of billing codes, which has been proven to be variable due to incompleteness of data, clerical error and limited precision.²⁴ Consequently, our data are subject to possible mis-classification bias. Additionally, we have limited ability to make inferences regarding relevant health outcomes because our data source is an administrative database with limited relevant clinical and health outcome information. In our bivariate analysis we found statistically significant differences between all characteristics including clinical setting, which is likely driven by our large sample size; however, these findings may not represent clinically significant differences. We did not investigate differences in STI testing among medically complex adolescents, however this population, though frequently cared for in the hospital setting, may have unmet sexual health needs and hence represent an important topic for future study.²⁵ We were unable to identify adolescents who were

sexually active or presenting with an STI-related chief complaint because this information was not represented in our data source. Hence, we are unable to assess how many missed opportunities for STI screening occurred due to our inability to identify at-risk adolescents based on history and/or reported symptoms.

Implications and Contribution

STI testing in the hospital-based setting occurred infrequently and varied according to patient characteristics, as well as between hospitals. Potential drivers include varying hospital- and provider-specific cultures, programs and clinical practices. Further investigation is warranted to more clearly define the presence and impact of these potential drivers, with the ultimate goal of improving adolescent access to STI testing in the hospital setting.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements:

Dr. Goyal reports support from NIH grant K23 HD070910 (MKG). The remaining authors have no financial relationships relevant to this article to disclose. There was no grant support for this study. The authors have no conflicts of interest relevant to this article to disclose.

Abbreviations:

STI	Sexually transmitted infections
ED	Emergency department
US	United States
CT	Chlamydia trachomatis
GC	Neisseria gonorrhoeae
HIV	Human immunodeficiency virus
PHIS	Pediatric Health Information System
Q	Median household income quartile
syphilis	Treponema pallidum
TV	Trichomonas vaginalis

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Figure 1: Inter-Hospital Variability in Adjusted Rates of STI Testing within the ED and Inpatient Settings

Each PHIS hospital is represented by one dot, x-axis represents adjusted rates of STI tests performed in the ED, y-axis represents adjusted rates of STI tests performed in the inpatient setting for each hospital. Shaded area represents 95% CI, dotted line represents prediction interval. The coefficient of determination, adjusted $R^2=0.99$, $p<0.001$, demonstrates strong correlation between adjusted STI testing rates in the two settings within individual hospitals.

Table 1:

Comparison of Patient and Hospital Characteristics by STI Testing Status

	Total	No STI Test	STI Test
Encounters, N (column %)	541,714	482,556	59,158
Age (years)			
14	129,502 (24)	119,309 (25)	10,193 (17)
15	130,589 (24)	118,230 (25)	12,359 (21)
16	125,047 (23)	111,028 (23)	14,019 (24)
17	109,656 (20)	95,038 (20)	14,618 (25)
18	46,920 (9)	38,951 (8)	7,969 (13)
Gender *			
Female	303,129 (56)	264,054 (55)	39,075 (66)
Insurance Type			
Government	309,554 (57)	272,967 (57)	36,587 (62)
Commercial	194,059 (36)	175,937 (36)	18,122 (31)
Self-Pay	23,258 (4)	20,392 (4)	2,866 (5)
Other	14,843 (3)	13,260 (3)	1,583 (3)
Race/Ethnicity			
Non-Hispanic white	222,139 (41)	200,499 (42)	21,640 (37)
Non-Hispanic black	141,429 (26)	122,157 (25)	19,272 (33)
Hispanic	126,382 (23)	114,671 (24)	11,711 (20)
Asian	8,112 (2)	7,292 (2)	820 (1)
Other	43,652 (8)	37,937 (8)	5,715 (10)
Clinical Setting at Discharge			
ED	405,918 (75)	371,001 (77)	34,917 (59)
Inpatient/Observation	135,796 (25)	111,555 (23)	24,241 (41)
Median Household Income Quartile **			
Q1: \$33,311	170,426 (32)	149,354 (31)	21,072 (36)
Q2: \$33,312–41,386	123,780 (23)	109,643 (23)	14,137 (24)
Q3: \$41,387–54,013	118,173 (22)	105,946 (22)	12,227 (21)
Q4: \$54,014	118,362 (22)	107,684 (22)	10,678 (18)
Hospital Region			
Northeast	79,234 (15)	69,527 (14)	9,707 (16)
South	214,213 (40)	191,092 (40)	23,121 (39)
Midwest	133,732 (25)	116,653 (24)	17,079 (29)
West	114,535 (21)	105,284 (22)	9,251 (16)

P-values <0.001 for all comparisons

* Missing data n=79 (No STI Test: 74, STI Test: 5)

** Missing ZIP code data n=10,973 (No STI test: 9,929, STI Test: 1,044)

Table 2:

STI Testing by Specific Infection

STI	STI Tests		
	Total, N	Single	Combination
GC/CT, n (row %)	54,940	44,531 (81)	10,409 (19)
Trichomonas vaginalis	2,116	78 (4)	2,038 (96)
Treponema pallidum	9,034	818 (9)	8,216 (91)
HIV	11,229	2,322 (21)	8,907 (79)

Table 3:

Association of Patient and Hospital Characteristics by STI Testing Status

		Adjusted Odds Ratio (95% CI)	Adjusted Probability of STI Test (95% CI)
Age (years)	14	Reference	0.08 (0.07,0.09)
	15	1.22 (1.19,1.26)	0.10 (0.08,0.11)
	16	1.45 (1.42,1.50)	0.11 (0.10,0.13)
	17	1.76 (1.71,1.81)	0.13 (0.12,0.15)
	18	2.15 (2.08,2.22)	0.16 (0.14,0.18)
Gender	Male	Reference	0.09 (0.08,0.10)
	Female	1.61 (1.58,1.64)	0.14 (0.12,0.16)
Payer	Commercial	Reference	0.09 (0.08,0.11)
	Government	1.27 (1.24,1.30)	0.12 (0.1,0.13)
	Self-Pay	1.33 (1.27,1.39)	0.12 (0.11,0.14)
	Other	1.29 (1.22,1.37)	0.12 (0.10,0.14)
Race/Ethnicity	Non-Hispanic white	Reference	0.10 (0.09,0.12)
	Non-Hispanic black	1.20 (1.17,1.23)	0.12 (0.11,0.14)
	Hispanic	1.04 (1.01,1.08)	0.11 (0.1,0.12)
	Asian *	1.05 (0.97,1.14)	0.11 (0.09,0.13)
	Other	1.11 (1.07,1.15)	0.11 (0.10,0.13)
Median Household Income Quartile	Q4: \$54,014	Reference	0.10 (0.09,0.12)
	Q3: \$41,387–54,013	1.10 (1.07,1.14)	0.11 (0.10,0.13)
	Q2: \$33,312–41,386	1.12 (1.09,1.16)	0.11 (0.10,0.13)
	Q1: \$33,311	1.21 (1.17,1.24)	0.12 (0.11,0.14)
Clinical Setting of STI Test	ED	Reference	0.09 (0.08,0.10)
	Inpatient/Observation	1.59 (1.56,1.62)	0.14 (0.12,0.16)
Hospital Region	West	Reference	0.09 (0.07,0.12)
	South *	1.29 (0.89,1.87)	0.11 (0.09,0.14)
	Midwest *	1.44 (0.94,2.20)	0.13 (0.10,0.16)
	Northeast *	1.38 (0.86,2.20)	0.12 (0.09,0.16)

* Indicates p-value >0.05, otherwise all p-values = 0.05

Data are presented as adjusted odds ratios and adjusted probabilities of STI testing. Model is adjusted for age, gender, payer, race/ethnicity and median household income.