

An Electronic Alert for HIV Screening in the Emergency Department Increases Screening but not the Diagnosis of HIV

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Keywords

HIV testing, electronic alert, electronic order set, screening test

Summary

Objective: Based on US. Centers for Disease Control and Prevention recommendations, New York State enacted legislation in 2010 requiring healthcare providers to offer non-targeted human immunodeficiency virus (HIV) testing to all patients aged 13–64. Three New York City adult emergency departments implemented an electronic alert that required clinicians to document whether an HIV test was offered before discharging a patient. The purpose of this study was to assess the impact of the electronic alert on HIV testing rates and diagnosis of HIV positive individuals.

Methods: During the pre-intervention period (2.5–4 months), an electronic “HIV Testing” order set was available for clinicians to order a test or document a reason for not offering the test (e.g., patient is not conscious). An electronic alert was then added to enforce completion of the order set, effectively preventing ED discharge until an HIV test was offered to the patient. We analyzed data from 79,786 visits, measuring HIV testing and detection rates during the pre-intervention period and during the six months following the implementation of the alert.

Results: The percentage of visits where an HIV test was performed increased from 5.4% in the pre-intervention period to 8.7% ($p < 0.001$) after the electronic alert. After the implementation of the electronic alert, there was a 61% increase in HIV tests performed per visit. However, the percentage of patients testing positive per total patients-tested was slightly lower in the post-intervention group than the pre-intervention group (0.48% vs. 0.55%), but this was not significant. The number of patients-testing positive per total-patient visit was higher in the post-intervention group (0.04% vs. 0.03%).

Conclusions: An electronic alert which enforced non-targeted screening was effective at increasing HIV testing rates but did not significantly increase the detection of persons living with HIV. The impact of this electronic alert on healthcare costs and quality of care merits further examination.

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Introduction

The human immunodeficiency virus (HIV) epidemic continues to exact a huge toll on the United States (US) population. Despite increasingly intensive public health efforts, about 20% of HIV-positive individuals (i.e., approximately 200,000) are unaware of their HIV status, because most Americans have never been tested for HIV and are not aware that they are at-risk for the disease [1, 2]. An important approach to controlling the HIV epidemic is early identification, since late diagnosis results in increased potential for transmission and delays life-saving treatment [3]. Early diagnosis of the disease, through HIV testing, is vital to avoid increased transmission, and link patients to care, resulting in decreased morbidity and mortality [4].

The National HIV/AIDS Strategy has established a goal of increasing the awareness of HIV status in the US population from 79% to 90% by 2015 [5]. In recent years, several initiatives have sought to increase the number of persons who know their HIV status. In 2006, the U.S. Centers for Disease Control and Prevention (CDC) began recommending non-targeted HIV testing to be offered in healthcare delivery settings unless the prevalence of new HIV diagnoses is less than 0.1% [6]. In response to the CDC recommendation, New York State enacted legislation in 2010 mandating that HIV testing be offered to all persons between the ages of 13 and 64 seeking healthcare services in all settings, including primary care and specialty care practices, emergency departments (EDs), and inpatient hospital facilities [7]. Expanding HIV testing in the ED is especially important [8, 9] because those who use the ED for primary care services are most likely to be affected by HIV/AIDS [10]. Implementing non-targeted HIV screening in the ED setting, however, presents operational and financial challenges, particularly in urban environments where EDs are often overcrowded [11-17] and understaffed [18-20]. To further complicate these challenges, there is no public funding to support the New York State HIV testing legislation.

Electronic alerts are a common type of decision support for clinicians at the point of care [21]. However, the costs and benefits of such tools are coming under increased scrutiny. A recent study reported on the use of computer-facilitated HIV testing which was reported to be acceptable to ED patients but did not assess the impact of this tool on HIV testing rates and the detection of persons living with HIV [22]. In another study, a clinical informatics tool was developed to determine which ED patients are eligible for HIV screening. Findings from this study demonstrated that clinical informatics tools can be used to increase program efficiency and accelerate the integration of HIV screening into clinical practice in an ED universal HIV screening program [23]. These recent studies shed light onto the usefulness of informatics tools for improving the HIV testing process in the ED but further research is needed to understand how these tools impact the detection of persons living with HIV. The goal of this study was to measure the effectiveness of an electronic alert on HIV testing rates and diagnosis of HIV-positive individuals in the adult ED.

Methods

Study Setting

The study was conducted at three adult EDs in New York City. All three sites were part of the same hospital network and are private not-for-profit institutions. Site 1 is a community hospital associated with a major academic medical center and had an annual ED volume of 41,000 patients. Sites 1 and 2 have overlapping geographic areas served. Site 2 was a New York State-designated AIDS Center, with an annual ED volume of 79,000 patients. Designated AIDS Center (DACs) are state-certified, hospital-based programs that provide multi-disciplinary inpatient and outpatient care coordinated through hospital-based case management and there are 41 throughout New York State. The prevalence of persons living with HIV in the 5 zip codes most closely bordering sites 1 and 2 is 16.79 per 1,000 persons in 2011 [24, 25]. Sites 2 and 3 are tertiary care academic medical centers Site 2 is a level one trauma center for pediatrics. Site 3 is a level one trauma center for adult and pediatrics and was also a DAC with annual ED volume of 67,000 Adult patients [26]. This site has 4 neighboring zip codes with a total prevalence of 16.77 per 1,000 persons living with HIV in 2011 [25]. Notably

the prevalence of persons living with HIV in the catchment area of site 3 is slightly lower than in the other two sites.

Intervention

In order to comply with the New York State HIV testing legislation, all three sites deployed an electronic “HIV Testing” order set and an electronic alert to ensure that an HIV test was offered to every patient discharged from the ED. Patients were offered to be given an HIV test which was billed to their medical insurance. In the case of patients who were uninsured, the hospital paid for the testing. We defined two study periods:

1. pre-intervention, HIV Testing order set available without an electronic alert; and
2. post-intervention, HIV Testing order set available and electronic alert enabled.

During the pre-intervention period, clinicians could access the HIV Testing order set (► Figure 1), but there was no electronic alert. The HIV Testing order set included three options:

1. order a rapid HIV test,
2. document that HIV testing was offered but declined by the patient, and
3. document that HIV testing was not offered (a reason was required if option 3 was selected – for example, “Patient is known HIV-positive”).

The time period when the HIV Testing order set was live, but no alert occurred, was defined as the pre-intervention period. At sites 1 and 2, this duration was four months; at site 3, the duration was two and a half months. The pre-intervention time period was determined by hospital and ED administration as the time that was necessary to introduce the new clinical process and documentation to the staff at each site.

During the post-intervention period, the electronic alert was implemented to enforce the HIV testing policy. An electronic alert was added to ensure that providers, including attending physicians, resident physicians, physician assistants, or nurse practitioners, offered HIV testing to patients and completed the HIV Testing order set. An electronic alert was used because it was a relatively inexpensive method for implementing a necessary clinical action for almost every patient visit in the ED. The alert appeared when a clinician electronically placed the “ED Discharge Order,” at the end of the patient visit, if the HIV Testing order set was not previously completed during the ED visit. The alert appears at the same time in all three sites. The alert prevented the clinician from continuing with the discharge order until the HIV Testing order set was completed. The post-intervention time period was six months after the introduction of the electronic alert at each site. We chose six months as a convenience sample of data which was available at the time that we analyzed our data. We chose an equal period of time for our post-intervention data across sites.

Measurements

Institutional Review Board (IRB) approval was obtained prior to conducting the study. We analyzed data from the electronic health record system used across all three EDs, (Sunrise Emergency Care, Allscripts Corporation, Chicago, IL) to understand the effect of the implementation of the HIV testing electronic alert on testing rates and detection of persons living with HIV. We obtained de-identified patient visit information for treat-and-release patients at the three EDs before and after the implementation of the electronic alert. The visit information included patient age, sex, whether blood work was ordered, and emergency severity index (ESI). ESI is categorized on 5 levels: 1-resuscitation, 2-emergent, 3-urgent, 4-less urgent, 5-non-urgent [27]. We included only treat-and-release patients, who are patients who were seen in the ED and then discharged without being admitted to the hospital. We only included treat-and-release patients in our study for three reasons:

1. these patients constituted the vast majority of ED visits,
2. patients who were admitted frequently had HIV testing performed during their inpatient stay, and
3. at the time of the study, the electronic alert was active only for treat-and-release patients.

Patient insurance information was not available in our data set. Race and ethnicity were not included in this study because this information was classified as “Unknown” or “Other” for more than half of the patients. We excluded patients over 64 years of age since this population was not included in the New York State HIV screening legislation. We only assessed adult EDs, since the testing process was different in the institution’s pediatric and psychiatric EDs.

Two outcome measures were used to determine the impact of the HIV testing electronic alert: overall HIV testing rate, and the detection rate of HIV-positive patients. Overall HIV testing rate was defined as the total number of HIV tests completed divided by the total number of patient visits. Detection of HIV-positive patients was determined by the number of HIV positive patients divided by the total number of patients tested.

Data Analysis

Data were managed and analyzed using IBM SPSS Statistics, release 20.0 (IBM Corp., Chicago, IL). Descriptive statistics were used to characterize patient demographics, HIV testing rates, and the percentage of persons who were diagnosed with HIV. Results are presented as frequencies with proportions. We used logistic regression to assess the effect of implementation of this electronic alert on the completion of the HIV Testing order set and testing a patient for HIV among all of the patients. We also analyzed the predictors of testing positive among the 6,279 patients who were tested for HIV to suggest further research on targeted HIV screening. Adjusted logistic regression models included the following covariates: ED site, patient age, patient sex, orders for other blood work, and ESI. Odds ratios are presented with 95% confidence intervals (CIs).

Results

A total of 79,786 patient records were examined. Mean age of patients was 39.1 years (S.D. = 12.7). Additional patient demographics are reported in ► Table 1. During the pre-intervention period, there were a total of 29,993 visits at the three study sites. During the six-month post-intervention period, 49,793 patient visits were analyzed. Clinicians completed the HIV Testing order set for 32.2% of patients during the pre-intervention period and for 100% of patients during the post-intervention period. In the post-intervention period, 100% of patients were offered the test because clinicians has no choice but to complete the order set if they wanted to proceed with discharging the patient. Across all three sites, patients in the post-intervention group were tested for HIV at a significantly higher rate than patients in the pre-intervention group (OR = 1.66; 95% CI, 1.57–1.77; $p < 0.001$) (► Table 2). There were a total of 30 patients who tested positive for HIV during the entire study period, 9 patients in the pre-intervention group and 21 patients in the post-intervention group. Of the 30 patients who tested positive, 20 were male.

The percentage of patients-testing-positive per total-patients-tested was lower in the post-intervention group than the pre-intervention group (0.48% vs. 0.55%) $p = 0.89$. The number of patients-testing-positive per total-patient-visits was higher in the post-intervention group (0.04% than the pre-intervention group (0.03%), $p = 0.50$. The percentages are very similar in the pre-intervention and post-intervention groups and the differences are not significant.

Predictors of Ordering an HIV test

Clinicians were more likely to order an HIV test during the post-intervention period compared to the pre-intervention period (OR = 1.41; 95% CI, 1.33–1.49; $p < 0.001$). Patients at site 1 (OR = 1.18; 95% CI, 1.09–1.28; $p < 0.001$) and site 2 (OR = 1.92; 95% CI, 1.79–2.05; $p < 0.001$) were more likely to agree to be tested for HIV than patients at site 3 (► Table 3). ESI was a significant covariate in our model ($p < 0.001$), and lower-severity patients were more likely to be tested for HIV. Younger age had a small effect on testing rates (OR = 0.98; 95% CI, 0.97–0.98; $p < 0.001$). Patients who had other blood work during their ED visit were more likely to be tested for HIV (OR = 1.45; 95% CI, 1.36–1.54; $p < 0.001$). Patient sex was not a significant covariate in this model.

Predictors of Detecting HIV-Positive Patients

Among patients who were tested for HIV, there was no significant difference in detection of HIV-positive patients between the pre- and post-intervention periods ($p = 0.549$). Site ($p = 0.183$), age ($p = 0.716$), ESI ($p = 0.666$) and other blood work ($p = 0.202$) were not significant covariates in this model. Sex was a significant covariate; of the patients who were tested, males were more likely to be HIV-positive than females (OR = 2.63; 95% CI, 1.22–5.68; $p = 0.014$).

Discussion

After implementing the electronic alert, we observed a significant increase in the rate of HIV tests performed (5.4% across all sites during the pre-intervention period, increasing to 8.7% during the post-intervention period). Interestingly, even the pre-intervention testing rate was much higher than rates reported in the 2009 National Hospital Ambulatory Medical Care Survey (NHAMCS) [28]. This survey demonstrated that nationwide, overall HIV testing rates in the ED for patients aged 13–64 was only 0.2%. Among patients with increased risk for HIV and other sexually transmitted diseases or pregnancy, only 2.3% were tested for HIV [28]. Since the HIV testing rates in the pre-intervention group were already higher than the national testing rates, an electronic order set without an electronic alert may be more appropriate, targeted and cost-effective than an electronic alert at detecting new cases of HIV in the ED. An interruptive hard stop alert that forces 100% completion may invite providers to complete the order set without actually offering the HIV test.

Our results suggest that there are limits to the effectiveness of an electronic alert for implementing universal non-targeted HIV screening in the ED. While the overall detection of HIV-positive persons increased with an increase in testing rates, the rate of detection of HIV-positive patients per patient-tested decreased. The patients in the post-intervention group who were tested for HIV were not significantly more likely to be diagnosed with HIV than patients in the pre-intervention group, despite higher testing rates in this group. This finding suggests that the rate of HIV detection does not linearly increase with increased screening.

In a similar study to ours, Avery et al. implemented an electronic reminder to alert providers to the absence of an HIV test among all patients' ages 13–64 years old in the primary care setting [29]. In that study after the implementation of HIV testing reminders, first-time HIV testing increased significantly for both men and women 18–64 years old, resulting in a significant reduction in missed opportunities. While Avery and colleagues did not assess whether there was an increase in detection of persons living with HIV, our study found similar results in the ED setting with respect to increases in testing. Additional research is warranted to understand whether use of an electronic alert for implementing non-targeted HIV screening in the ED is cost-effective, which would inform future policy decisions. In the case of this legislation, the State did not provide any financial support and so the cost burden of the increased staffing and changes to the electronic health record were assumed by the hospital system. Although previous studies have demonstrated the cost-effectiveness of performing routine non-targeted HIV screening [4, 30], further examination of our results using a cost-effectiveness analysis could provide evidence as to whether targeted screening would be more effective.

ESI and patients having other blood work were significant predictors of a patient agreeing to be tested for HIV. Lower-severity patients and patients who were already having blood work performed were more likely to be tested for HIV. This is not surprising, since additional testing fits conveniently within clinicians' workflow and is less burdensome to patients. Site was a significant covariate in our models.

While the HIV Testing Order Set was completed more than three times as often in the post-intervention period, there were only 1.4 times as many HIV tests. One explanation for this change is that an alert at time of discharge does not fit neatly within the clinicians' workflow. There was concern among providers that having an electronic alert earlier in the workflow may interrupt necessary and emergent care and so the hospital and ED administration decided to place the alert at the end of the visit. Because the alert now appears at the end of the patient visit, this may have reduced the likelihood that the HIV test was actually performed. Since drawing of other blood increased the chance

of performing an HIV test, it is important to consider moving the alert earlier in the workflow. If an alert triggers at the time when clinicians are ordering other blood work, this may increase the likelihood of ordering an HIV test.

Patients at sites 1 and 2 were more likely to agree to be tested for HIV than at site 3. This difference may be the result of higher prevalence of HIV in the catchment area of sites 1 and 2 than site 3 [31]. Alternatively, providers may have been more persuasive in offering the HIV test at these sites because the prevalence of the disease is higher in these areas. Patient sex was a significant predictor of detecting HIV, and of those patients tested, males were more likely to be HIV-positive. Since the incidence of HIV is much higher in men than women, and men are more likely to become newly infected with HIV, these findings are consistent with the current epidemiology of the disease [32]. Gay and bisexual men remain the population most heavily affected by HIV in the US with estimates that they represent approximately 2% percent of the U.S. population, but accounted for the majority of all new HIV infections annually from 2006 to 2009— 56% in 2006 (27,000), 58% in 2007 (32,300), 56% in 2008 (26,900) and 61% in 2009 (29,300) [33].

Particular attention should be focused on the effect of non-targeted HIV screening on ED congestion and staffing [20, 34]. ED crowding is a growing national crisis and is associated with workflow challenges [13-15]. Lack of clinician time is a commonly cited barrier to implementing initiatives like HIV testing; it is likely one of the major challenges in complying with the current legislative mandate in New York State [35]. In past studies, ED physicians reported spending less than ten minutes with each patient, illustrating the complexity of implementing mandatory non-targeted HIV testing [36]. Future research should consider the effect of this legislation on patient outcomes and quality of care.

Limitations

There were limitations to our study. First, factors such as staffing level or provider type information were not available for our analysis and this may have an effect on testing rates. Second, the number of patient visits differed considerably between sites. In the multivariable model, we controlled for these differences but were not able to control for ED congestion, which could be an important covariate. Third, the geographic setting limits the generalizability of the findings – our study was conducted in three busy urban EDs which may vary greatly from rural and less-congested environments.

Finally, our unit of analysis was the patient visit and so we may have had patients in our study sample that had repeat visits to the same ED. At the time of our study, even if a patient had been previously tested, the provider would still receive an HIV Testing electronic alert before discharging a patient. The alert has been revised since our study period to only require a provider to offer the HIV test if a patient does not have documentation of an HIV test in the past 12 months.

In conclusion, the patients in the post-intervention group who were tested for HIV were not significantly more likely to be diagnosed with HIV than patients in the pre-intervention group, despite higher testing rates in this group. This finding suggests that the rate of HIV detection does not linearly increase with increased screening. An electronic alert which enforced non-targeted screening was effective at increasing HIV testing rates but did not significantly increase the detection of persons living with HIV. The impact of this electronic alert on healthcare costs and quality of care merits further examination.

Conflicts of Interest

None of the listed authors have any financial or personal relationships with other people or organizations that may inappropriately influence or bias the objectivity of submitted content and/or its acceptance for publication in this journal.

Protection of Human Subjects and Animals in Research

The procedures used have been reviewed in compliance with ethical standards of the responsible committee on human experimentation at the home institution of the authors. All research activities are in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects.

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HIV Testing Order Set [1 orders of 3 are selected]

Order	Reason	Comment
HIV Testing Deferred - 2 item(s)		
<input checked="" type="checkbox"/> HIV Test Not Offered		
<input type="checkbox"/> HIV Test Offered and Declined	Patient reports previous HIV test is positive Age <13 or >65 Patient unable to give informed consent Patient treated for life threatening emergency Patient is already tested at our institution Other (explain in comments)	
HIV Testing		
Order		Comments
HIV Testing - 1 item(s)		
<input type="checkbox"/> HIV 1 and 2 Rapid		STAT

Drug Info OK Cancel

Fig. 1 Electronic HIV Testing Order Set

Alert Summary

Ack...	Viewed	Doc...	Alert	Priority	Type	Comment	Scope
	<input checked="" type="checkbox"/>		Unacknowledged Results: Please	HIGH	WARNING		Chart
	<input type="checkbox"/>		ED Diagnosis/Attestation	LOW	WARNING		Chart
	<input checked="" type="checkbox"/>		HIV Testing	LOW	REMINDER		Chart
	<input type="checkbox"/>		Medication Reconciliation Attestation	LOW	WARNING		Chart

Alert: HIV Testing

Message: Please enter one of the choices/orders from the HIV Testing Order Set before completing a bed request.

[Expand](#)

Acknowledgement Comment:

You may not proceed with this Order Set

Acknowledge << Previous Alert 3 of 4 Next >>

To continue with the Order Set unchanged click Proceed.

To return to the Order Set and discard alerts click Go Back.

Proceed Go Back Help

Fig. 2 HIV Testing Alert

Table 1 Patient Demographics

	Total N (%)	Site 1	Site 2	Site 3
Variable	79,786	19,601 (24.6)	35,916	24,269
Gender				
Male	34,472 (43.2)	7,602 (38.8)	16,140 (44.9)	10,730 (44.2)
Blood Work other than the HIV test				
Yes	29,650 (37.2)	6,768 (34.5)	13,484 (37.5)	9,398 (38.7)
Emergency Severity Index (ESI)				
1-resuscitation	56 (0.1)	4 (0.02)	44(0.1)	8 (0.03)
2-emergent	6,495 (8.1)	571 (2.9)	5,359 (14.9)	565 (2.3)
3-urgent	46,699 (58.5)	10,324 (52.7)	22,813 (63.5)	13,562 (55.9)
4-less urgent	24,064 (30.2)	7,989 (40.8)	7,073 (19.7)	9,002 (37.1)
5-non-urgent	2,472 (3.1)	713 (3.6)	627 (1.7)	1,132 (4.7)

Table 2 Number of Each HIV testing Order and Percentage of Patients Tested and HIV Positive

	Group 1 Pre-intervention (N = 29,993)	Group 2 Post-Intervention (N= 49,786)
Site 1		
HIV Testing Order Set Completed	5,709	11,170
● HIV Test Ordered	470	788
– Positive	2	1
– Negative	468	787
● Total Patient Visits	8435	11183
% Tested	5.57	7.05
% Positive of Total Tested	0.43	0.13
% Positive of Total Visits	0.024	0.009
Site 2		
HIV Testing Order Set Completed	3,699	21,145
● HIV Test Ordered	1042	2304
– Positive	7	15
– Negative	945	2061
● Total Patient Visits	14782	21172
% Tested	7.05	10.88
% Positive of Total Tested	0.67	0.65
% Positive of Total Visits	0.047	0.071
Site 3		
HIV Testing Order Set Completed	447	17,478
● HIV Test Ordered	119	1261
– Positive	0	5
– Negative	119	1256
● Total Patient Visits	6811	17521
% Tested	1.75	7.20
% Positive of Total Tested	0.00	0.40
% Positive of Total Visits	0.00	0.03
All Sites		
HIV Testing Order Set Completed	9,676	49,786
● HIV Test Ordered	1631	4353
– Positive	9	21
– Negative	1532	4104
% Tested	5.43	8.73
% Positive of Total Tested	0.55	0.48
% Positive of Total Visits	0.030	0.042

Table 3 Odds ratios of gender, location, other blood work and severity index related to ordering an HIV test

Variable	Odds ratio	95% Confidence interval	p value
Gender			
Female (reference)	1.00		0.06
Male	1.06	1.00, 1.11	
Location			
Site 1	1.18 ^b	1.09, 1.28	<0.001
Site 2	1.92 ^b	1.79, 2.05	
Site 3 (reference)	1.00		
Other Blood Work			
No (reference)	1.00		<0.001
Yes	1.45 ^b	1.36, 1.54	
ESI			
1-resuscitation	0.13 ^a	0.02, 0.96	<0.001
2-emergent	0.56 ^b	0.46, 0.68	
3-urgent	0.85 ^a	0.72, 1.00	
4-less urgent	1.02	0.87, 1.20	
5-non-urgent (reference)	1.00		

^aStatistically significant at 0.05 level^bStatistically significant at 0.001 level

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