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Impact of the COVID-19 pandemic on an emergency department-based opt-out HIV screening program in a South Florida hospital: An interrupted time series analysis, July 2018-March 2021

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Background: The COVID-19 pandemic has posed a tremendous burden on healthcare services. We evaluated its impact on an emergency department (ED)-based opt-out Human immunodeficiency virus (HIV) testing in a public healthcare system.
Methods: The programmatic data of ED-based HIV testing from July 2018 to March 2021 at the Memorial Regional Hospital, Hollywood, Florida was analyzed by interrupted time series analysis to evaluate the immediate and gradual effects of the COVID-19 pandemic on the number of monthly HIV tests, with an interruption point at March 2020.
Results: The average number of monthly HIV tests were significantly lower during the pandemic than the pre-pandemic (791 ± 187 vs 1745 ± 266, $P < .001$). There was a slight decline trend in the number of monthly HIV tests before the pandemic (estimate -10.29, $P = .541$). HIV testing dramatically decreased during the initial 7 months of the pandemic, compared to the pre-pandemic period, with the largest decline in the number of HIV tests on March 2020 (estimate -678.48, $P = .007$). HIV testing slightly increased every month (estimate 4.84, $P = .891$) during the pandemic period, and the number of HIV tests per month rebounded to the pre-pandemic levels by October 2020.
Conclusions: ED-based HIV testing significantly decreased during the initial 7 months of the pandemic in south Florida. Multiple strategies are necessary to maintain HIV testing during this pandemic era.

INTRODUCTION

Human immunodeficiency virus (HIV) infection remains an important public health problem throughout the world. It is estimated that more than 1.2 million people are living with HIV in the U. S., while approximately 13% of those with HIV are unaware they are infected.[1] Located in south Florida, both Broward and Miami-Dade Counties continue to have the highest rate of new HIV diagnoses in the U.S., according to the Centers for Disease Control and Prevention's latest HIV Surveillance Report.[2] The new guidelines recommended routine opt-out HIV screening in health care settings, including emergency departments (EDs), where the prevalence of undiagnosed infection is 0.1% or greater.[3,4] ED-based HIV screening approach has been shown to identify HIV prevalence rates of 0.1%-1.7%.[5,6] In July 2018 we implemented the ED-based opt-out HIV screening program at the Memorial Healthcare System (MHS) in south Florida and identified HIV prevalence rate of 0.5%.[7]

Routine HIV screening can prove challenging due to the ED's complexity and competing priorities. The COVID-19 pandemic, caused by the acute respiratory coronavirus 2 (SARS-COV-2), became a serious challenge to health care systems globally since its first report in December 2019.[8] COVID-19 control measures such as lockdowns, ED priorities, and/or social distancing were vital for containing the spread of the COVID-19 pandemic, but might have had severe

collateral effects on existing health care services, like ED-based HIV screening programs.[9] The COVID-19 pandemic across the U.S. with extensive publicity and lockdowns began in mid-March 2020. Herein, we report the results of ED-based opt-out HIV tests between July 2018 and March 2021 at MHS. We defined the COVID-19 pandemic that interrupted the time series as the month of March 2020, the month strict COVID-19 lockdown measures went into effect in South Florida. We quantified the impact of the COVID-19 pandemic on the number of HIV tests per month using direct before-and-after comparison and interrupted time series analysis (ITS) with segmented regression models.

METHODS

Study setting and population

This institution based retrospective cohort study was conducted at MHS, Hollywood, Florida between July 2018 and March 2021. HIV testing was offered on an "opt-out" basis to patients aged 16 years or older who presented to the EDs for routine blood tests. "Opt-out" HIV screening orders were automatically initiated in the electronic medical record admission orders to be authorized by the trained nurse. Patients were given information related to an additional blood test to screen for HIV, unless they declined, during the ED registration process. Patients who were offered blood tests had their decision documented and coded in their electronic files. Patients were excluded from testing if they opted out, had a previous diagnosis of HIV infection or clinical evidence of HIV infection in the admitted patient's medical record or if they did not understand their right to opt-out.

Data sources

Data on the number of HIV tests done per month at the ED were routinely recorded in the programmatic database of MHS. The number of ED-based HIV tests per month from July 2018 to March 2021 were extracted from the programmatic data and were analyzed.

Statistical analysis

Descriptive statistics of mean, standard deviation, and range were calculated before and during the pandemic. There were 33 calendar months in time series, with 20 months pre-pandemic (July 2018-February 2020) and 13 months during the pandemic (March 2020-March 2021) segments. First, we computed mean number of monthly HIV tests for the periods before and during the pandemic and Student's t-test was used to determine whether these numbers differed significantly before-and-after pandemic, as all data were found to be normally distributed (Kolmogorov-Smirnov test).

To better understand the trends of the number of HIV tests per month during the COVID-19 pandemic, we performed an ITS segmented regression analysis[10,11] to examine changes in the number of HIV tests per month over time, with an interruption point that began on March 2020, using the following autoregressive error linear regression model: $Yt = \beta_0 + \beta_1 T + \beta_2 Xt + \beta_3 TXt$, where Yt represents the number of HIV tests per month; T represents time in months since the start of the study period; Xt is binary variable indicating the pre-pandemic (coded 0) or the post-pandemic period (coded 1); TXt represents the number of months after the pandemic at time t, coded 0 before the pandemic and coded 1-13 after the pandemic. β_0 estimates the baseline level of HIV tests per month at T = 0, β_1 is the baseline slope that estimates the change in HIV tests month-to-month before the pandemic, β_2 estimates the immediate change in HIV tests at the time the pandemic occurred, β_3 represents the slope change following the pandemic. Seasonality of the time series data was examined with Chi-square test, and we confirmed the absence of seasonal distribution of the HIV tests through the timing chart. The presence of autocorrelation within the data was excluded by plotting the residuals and checking for normality (Kolmogorov-Smirnov test). Using the parameter estimates resulting from the regression models, we compared the estimated number of HIV tests per month during the pandemic to the counterfactual number of HIV tests per month estimated in the absence of the pandemic. The impact of the COVID-19 pandemic on HIV testing was expressed as the absolute difference with 95% confidence intervals in the number of HIV tests per month between the predicted numbers of HIV tests per month during the pandemic and the counterfactual tests per month in the absence of the pandemic. Statistical analyses were performed using Prism version 7.01 and SPSS Statistics software version 27 (IBM Corp.). P values reported are 2-tailed, with a significance level of .05.

Ethical approval and informed consent

The retrospective chart review protocol was approved by the MHS Institutional Review Board (MHS.2019.119). Written informed consent was waived as this study involved only secondary data analysis.

RESULTS

A total of 45,185 HIV tests were recorded at MHS over the study period, of which 77% were tested before the pandemic (July 2018—

Table 1
ED-based "opt-out" HIV tests between July 2018 and March 2021, with the onset of the COVID-19 pandemic in March 2020

	Before the pandemic (July 2018—February 2020)	During the pandemic (March 2020—March 2021)	P value
ED visits			
Total numbers of ED visits	158278	79796	
Monthly ED visits	7914	6138	<.0001
Std. deviation	290.1	1172	
Median	7877	5950	
Minimum	7440	4375	
maximum	8557	9042	
Opt-out HIV tests			
Total numbers of HIV tests	34905	10280	
Monthly tests	1745	790.8	<.0001
Std. deviation	265.6	186.6	
Median	1755	721	
Minimum	1292	506	
maximum	2242	1128	

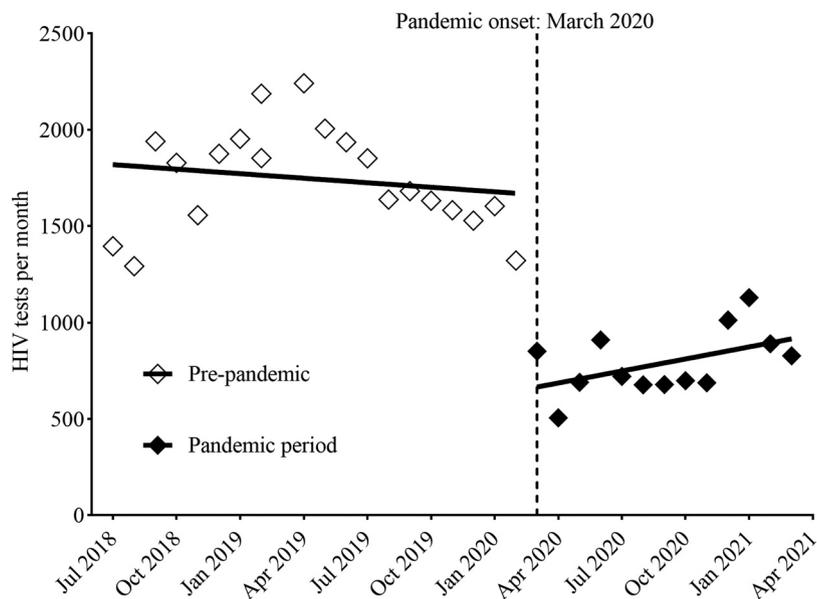ED, emergency department; HIV, human immunodeficiency virus.

Fig 1. Interrupted time series analysis of the trends of ED-based HIV tests 20 month before the pandemic and 13 months during the COVID-19 pandemic in MHS between July 2018 and March 2021, with the month of March 2020 as the interruption time point identified by the dashed vertical line. The 2 straight lines are best-fitting linear models for pre-pandemic period (July 2018▯—February 2020) and during the COVID-19 pandemic period (March 2020▯—March 2021) determined by interrupted time series segmented regression of the HIV tests per month between July 2018 and March 2021.

February 2020, 20 monthly time points) and 23% were tested during the pandemic period (March 2020—March 2021, 13 monthly time points) (Table 1). Analyses were performed to compare data from the 20 months before the pandemic with data from the 13 months of the pandemic period. The number of HIV tests per month decreased dramatically during the pandemic period, compared to the pre-pandemic period (Table 1; $P < .0001$). The impact of the pandemic on ED visits was in a manner similar to the HIV tests, which clearly demonstrated a drop in the number of ED visits per month during the pandemic period, compared to the pre-pandemic period (Table 1; $P < .0001$).

Figure 1 shows the trends of HIV tests per month before and during the pandemic period. There has been a slight downward trend in the number of HIV tests per month prior to the pandemic. On the onset of the pandemic (identified in Fig 1 as a vertical reference line labeled "Pandemic onset: March 2020"), there was a sharp decline in the number of HIV tests on March 2020 followed by a slight upward trend over the rest of the time period. Table 2 shows the results of ITS analysis based on the HIV tests per month between July 2018 and March 2021. The results indicate that just before the pandemic period, there had been an average of 1783 tests per month ($\beta_0 = 1783.11$, $P < .001$). Before the pandemic, there was no significant month-to-month change in the number of HIV tests per month

($\beta_1 = -10.29$; $P = .541$). While right after the pandemic started, the estimated number of HIV tests dropped abruptly by 683 tests per month ($\beta_2 = -683.31.48$; $P = .008$). There was no significant change in the month-to-month trend in the number of HIV tests per month during the pandemic period ($\beta_3 = 4.83$; $P = .891$).

Table 3 shows the estimated numbers of fewer HIV tests per month during the pandemic period compared with the pre-pandemic period as reference. There was a marked decline in the number of HIV tests per month, which was more pronounced during the early period of pandemic, particularly between March and September 2020 (all $P < .05$). In March 2020, the first month of the pandemic, there were 678 fewer HIV tests than predicted in the absence of the pandemic. In April 2020, there were 673 fewer HIV tests. The number of HIV tests per month between October 2020 and March 2021 was rebounded to the pre-pandemic levels (all $P > .05$).

Analyses were also performed to directly compare data from the 12 months before the pandemic with data from the 12 months of the pandemic period, Mach 2019 to February 2021, with the month of March 2020 as the onset of the COVID-19 pandemic. During the

Table 2
Parameter estimates, standard errors and *P*-values from the ITS models predicting mean monthly numbers of HIV tests from July 2018 to March 2021

Parameters	Estimate	Standard error	t	Sig.
β_0	1783.11	204.24	8.73	<0.001
β_1	-10.29	16.62	-0.98	0.541
β_2	-683.31	239.66	-2.85	0.008
β_3	4.83	34.98	0.14	0.891

β_0 = Intercept (estimated HIV tests before the pandemic).
β_1 = Change in the monthly HIV tests from July 2018 to February 2020.
β_2 = The level change in the monthly HIV tests immediately after the pandemic.
β_3 = Change in the monthly HIV tests after March 2020 compared with the monthly trend before the pre-pandemic.

Table 3
Changes of monthly HIV tests during the pandemic period compared with pre-pandemic as a reference

Month during the pandemic period	Relative changes of HIV tests	95% Confidence interval		P value
		Lower bound	Upper bound	
March 2020	-678.48	-1155.98	-200.98	.007
April 2020	-673.65	-1150.29	-197.00	.007
May 2020	-668.83	-1155.21	-182.45	.009
June 2020	-664.01	-1170.07	-157.95	.012
July 2020	-660.94	-1132.57	-189.31	.008
Aug 2020	-654.35	-1225.10	-83.59	.027
Sep 2020	-649.52	-1262.60	-36.44	.039
Oct 2020	-644.69	-1305.12	15.74	.056
Nov 2020	-639.87	-1351.64	71.91	.077
Dec 2020	-635.05	-1401.41	131.32	.102
Jan 2021	-630.22	-1453.73	193.28	.130
Feb 2021	-625.39	-1508.12	257.34	.159
March 2021	-620.57	-1564.19	323.05	.191

pandemic period (March 2020—February 2021), there was a marked decline in the number of ED visits and HIV tests per month, compared to the pre-pandemic period (March 2019—February 2020) (Supplementary Table S1). The trend of HIV tests per month was decreasing before the pandemic, however, after the pandemic, the number of HIV tests per month was increasing (Supplementary Figure S1). Supplementary Table 2 shows the results of ITS analysis based on the number HIV tests per month between March 2019 and February 2021. The number of HIV tests per month before the pandemic was estimated at 2,245, and the number of HIV tests per month decreased significantly every month until March 2020 according to the pre-pandemic slope ($\beta_1 = -73.45$; $P < .001$). At the onset of the pandemic, the number of HIV tests per month were significantly declined ($\beta_2 = -737.44$; $P < .001$). The estimates of the number of HIV tests per month had an increasing trend over the time after March 2020, with a slope of 98.29 ($\beta_2 = 98.29$; $P < .001$). Supplementary Table S3 shows the estimated number of fewer HIV tests per month during the pandemic period compared with the pre-pandemic period as a reference. There were significant declines in the number of HIV tests conducted per month during March—June 2020 (all $P < .05$), while the COVID-19 pandemic was in an emerging phase in the U.S., but rebounded to a lesser degree from July 2020 to January 2021 (all $P > .05$). However, the estimated number of HIV tests in February 2021 increased by 442, which was higher than the pre-pandemic level ($P = .041$). Importantly, these findings should only be considered valid for the duration of the study period.

DISCUSSION

The COVID-19 outbreak has had significant impacts on global healthcare systems.[12] This large population-based study in South Florida explored trends in ED-based "opt-out" HIV testing from July 2018 to March 2021, with the month of March 2020 as the interruption time of the COVID-19 pandemic. The results showed that the number of ED-based HIV tests per month significantly decreased during the months of March—September 2020, compared to the predicted number of HIV tests per month in the same period before the pandemic occurred. After the initial 7 months of the pandemic the number of HIV tests per month rebounded to the pre-pandemic levels. This finding is somewhat consistent with the "wave" of the COVID-19 infection in South Florida and a drop in ED visits during the pandemic period likely contributed to the decline in HIV tests.[13-15]

Data from the AIDS Healthcare Foundation Global Quality Program from 44 countries demonstrated a significant reduction in the number of HIV tests, ranging from 26.19% in Europe to 44.62% in Latin America, and 35.4% in the Caribbean, between January and August 2020, compared with the equivalent time period in 2019.[9] An ITS analysis of a large dataset from 65 South Africa primary care clinics between January 1, 2018 and July 31, 2020 showed a 47.6% decrease in HIV testing in April 2020.[16] In a recent report from The Joint United Nations Programme on HIV/AIDS also showed a reduction in HIV testing in 16 out of 19 countries, and a decline in initiation of antiretroviral therapy (ART) in 28 out of 29 countries.[17] Despite worldwide evidence showing that HIV testing has declined during the COVID-19 pandemic, data on the extent of these changes from the U.S. is very limited, with mixed trends in HIV tests, with some sites reporting decreases and some reporting no change. Moreover, most reports have focused on the first 3—6 months of the pandemic, and unlike our analysis, they do not account for long-term trends, which might have influenced outcomes. In our study, analyses were performed to compare data from the 20 months before the pandemic with data from the 13 months of the pandemic period. Our findings in South Florida area are in agreement with previous studies reporting a downward trend in HIV tests in diverse regions of the U.S. during the initial 9 months of the pandemic, compared to 2019.[18] We also

conducted a direct comparison of the number of HIV tests 12 months before the pandemic vs 12 months during the COVID-19 pandemic, and the results show a somewhat consistent pattern in terms of HIV testing changes, suggesting that the trends of HIV testing changes during the pandemic are real.

Several previous studies on the effect of COVID-19 on ED volume in the U.S. show a significant drop in ED visits compared to the same period a year earlier.[16-18] The measures used to control the COVID-19 pandemic, such as stay-at-home orders, quarantine, and excessive demands on laboratories tests for COVID-19 have likely contributed to the substantial decrease in ED visits during the pandemic. It is also possible that those experiencing mild symptoms opted to avoid ED visits because of lockdown restrictions and risks of COVID-19 infection. In this study, we observed a sharp decrease in the mean of monthly ER visits relative to a similar period of time pre-pandemic. As a consequence, this decline in ER visits was most likely contributing to the decline in HIV tests during the pandemic period.

Identification of HIV-infected persons early and timely initiation of ART play a key role in HIV prevention and treatment outcomes.[19,20] Being unable to maintain HIV testing during the COVID-19 pandemic is a significant hindrance to the achievement of the United Nations Programme on HIV/AIDS 95-95-95 goals by 2030.[16,21] Our findings indicate that ED-based opt-out HIV screening has been negatively affected during the pandemic, suggesting innovative strategies should be made to re-attain appropriate HIV testing even during the pandemic surges. HIV self-testing (HIVST) was reported to provide access to HIV testing safely while maintaining social distancing.[22] Additionally, HIVST affords individuals privacy and convenience that help expand the coverage of HIV testing to reach persons hindered from accessing facility-based testing.[23] As the COVID-19 crisis continues, the HIVST may be an alternative approach to maintain HIV testing among the general population in this era,[24,25] even though routine opt-out HIV testing remains the standardized test in healthcare settings. Moreover, individuals who seek care for COVID-19 should incorporate or even link HIV screening to COVID-19 testing as the previous report has demonstrated a considerable increase in HIV diagnoses with incorporating HIV screening into COVID-19 testing in the ED.[26]

There are several limitations to our study. First, a single healthcare system's data was used and the demographic information related to individuals and their presentations to HIV tests was not available. We were unable to examine potential subgroup differences, such as age, gender, or race related to HIV tests during the pandemic. Second, the ED in our sample represents only Broward & Miami-Dade Counties and surrounding areas, which is located in the pandemic's hotspots for both HIV and COVID-19. So the findings of this study might not be generalized to other geographically diverse sites. Lastly, the findings of this study should only be considered valid for the duration of the study period.

In conclusion, this study represents the assessment of pandemic-related changes in ED-based opt-out HIV testing in a community hospital in South Florida, and indicates that the COVID-19 pandemic has had negative consequences on HIV screening in emergency department. As the COVID-19 pandemic continues to cause challenges to the public health in the coming years, suitable strategies (eg, incorporating or even linking HIV screening to COVID-19 testing) should be implemented to enhance ED−based HIV screening programs, thus yielding more success for EDs in diagnosing HIV infection and linking patients to care.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.ajic.2022.05.004.

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