# A Smartphone Application to Reduce Time-to-Notification of Sexually Transmitted Infections

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*Objectives.* To measure whether the implementation of Healthvana—an online patient engagement platform and smartphone application—reduced the number of days between sexually transmitted infection (STI) testing, notification, and treatment at AIDS Healthcare Foundation (AHF) Wellness Centers.

*Methods.* We analyzed the retrospective data for 917 male clients who tested positive and received treatment for chlamydia, gonorrhea, or syphilis between January 1, 2014, and December 31, 2015. We included 8 AHF Wellness Centers from California and Florida in the study. We used regression models to evaluate the relationship between Healthvana implementation (pre-Healthvana vs post-Healthvana) and the number of days between the STI test, notification, and treatment.

*Results.* Following Healthvana implementation at the AHF Wellness Centers, the mean number of days decreased between the STI test and notification, from 8 to 6 days. The mean number of days between the overall STI test and treatment decreased from 12 to 10 days. Regression models found the reduction in the number of days from STI test to notification to be statistically significant.

*Conclusions.* Smartphone applications like Healthvana are promising technologies to ensure clients are successfully and immediately notified of their STI test results. (*Am J Public Health.* Published online ahead of print September 21, 2017: e1–e6. doi:10.2105/AJPH.2017.303999)

According to the Centers for Disease Control and Prevention, chlamydia, gonorrhea, and syphilis cases are on the rise, and these increasing rates have disproportionately affected men, particularly gay and bisexual men who have sex with men.[1] Although these 3 sexually transmitted infections (STIs) can be successfully treated and cured if diagnosed early, delays in treatment can lead to serious health complications and forward transmission.[2] Therefore, STI testing, notification, and treatment services are essential components of sexual health services to address the rising STI rates among men.[3]

Although STI testing has improved technologically, clinic staff members traditionally still notify clients regarding positive STI test results via telephone call.[4,5] Unfortunately, successful telephone contact with clients may be encumbered by incorrect contact information, missed calls, impacted clinic flow, or too few clinic staff members.[5,6] To curb hindrances, some clinics have turned to digital communication to better connect health care providers to their clients.[7]

Smartphone applications—computer programs designed for smartphones—have become a popular method of health care communication.[8] As smartphones improve in capacity, speed, security, and ubiquity, researchers are increasingly interested in whether smartphone applications will deliver the much-needed clinical efficiency for modern health care delivery systems. Although it may be that smartphones offer a digital medium that can communicate relevant, tailored messages and information to clients in ways that are unmatched by any previous technology, an important question is whether these applications work successfully for routine medical information notifications for STI testing clinics.

Before smartphone applications, mobile phone short message services (more commonly known as text messages) were used to improve STI client services through appointment reminders,[9,10] rescreening reminders,[11,12] general information about STIs,[13,14] sexual health promotion,[15,16] assistance with partner treatment,[17–19] and notification of STI test results.[4,20,21] For example, in the study by Menon-Johansson et al.,[4] clients who received their positive test results for chlamydia by text message not only received their diagnosis sooner, but were also treated sooner compared with clients who received their positive test results by telephone call. In the studies by Kegg et al.[10] and Dhar et al.,[20] clients were satisfied with receiving their STI test results via text message.

Text messages have demonstrated effectiveness, flexibility, and scalability as a health care intervention.[22] Unfortunately, most smartphone applications, including smartphone applications devoted to health, have been neither developed using evidence-based research nor evaluated using scientific methods.[23–25] In addition, health-related smartphone applications currently on the market lack diversity, with most smartphone applications targeting physical activity and weight management.[26–28] Smartphone applications that address other public health issues, such as STIs, ultimately lack proper evaluation.[25,29]

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Smartphone applications have the potential to offer STI test results to clients in a comprehensive and efficient manner that may exceed the rudimentary capabilities of text messaging. Text messages are limited to alphanumeric characters and ideograms (e.g., ☺), whereas smartphone applications can display visual information and incorporate interactive components and layers of content through hyperlinks. Smartphone applications can also build in 2-way information exchange. Although text messages rely on clients to actively respond that a text message has been read, smartphone applications can provide an automatic response back to the STI testing clinic about when and where clients checked their STI test results. Most importantly, smartphone applications include a myriad of software intricacies only limited by the operating system of the smartphone and the inventiveness of the designer, whereas text messages are just that—messages in the form of text.

Beginning in 2014, the AIDS Healthcare Foundation (AHF) began a pilot program with Healthvana to use its online patient engagement platform and smartphone application to improve STI notification for clients who seek STI testing services at AHF clinics, known as Wellness Centers, in California and Florida. The resulting service, also called Healthvana, was implemented at each AHF Wellness Center on a rolling basis (Figure 1) in which staff provided clients the opportunity to opt-in to receive their STI test results from Healthvana. Targeting a generation of smartphone-dependent "digital natives"[30]—individuals who grew up during the digital age and therefore who are most familiar with online communication—the goal was to reduce the number of days from the overall test to treatment by providing automatic and instantaneous STI test results to clients as a form of digital engagement. According to the creators of Healthvana, it ". . . allows clinics to handle patient intake and deliver lab results, next steps, care instructions, and reminders to patients in order to increase staff efficiency and patient retention."[31]

Using an intent-to-treat analysis, our objective in this study was to determine whether the implementation of Healthvana at AHF Wellness Centers reduced the number of days (1) from test to notification, (2) from notification to treatment, and (3) from overall test to treatment of clients.

## METHODS

To measure whether Healthvana reduced the number of days between STI test, notification, and treatment, we analyzed the retrospective data for male clients who sought chlamydia, gonorrhea, or syphilis testing at AHF Wellness Centers between January 1, 2014, and December 31, 2015. The data included 917 male clients who tested positive for chlamydia, gonorrhea, or syphilis; they were successfully notified of their positive STI test by either telephone call or Healthvana, and returned to an AHF Wellness Center for treatment. Although our study design was not randomized, the within-clinic variation allowed for a strong natural experimental design that controlled for differences across AHF Wellness Centers and time.

The main outcome variables were the number of days between STI test, notification, and treatment as recorded by Healthvana (notification date) and by the AHF Wellness Center staff (test date, telephone notification date, and treatment date).

The main predictor variable was whether the visit of the client was to an AHF Wellness Center at which Healthvana was offered at the time of the visit. In this sense, our analysis was an intent-to-treat analysis; those clients exposed to the treatment were all of those who had access to Healthvana, regardless of whether those clients chose to use Healthvana.

During the study period, all 8 AHF Wellness Centers included in this study implemented Healthvana, and data were available both before and after implementation (Figure 1). Each AHF Wellness Center served as its own control in a clinic-level, fixed-effects design. We also included a continuous time variable in the models to control for any secular trends in the outcome that might have happened. It was possible to include the time variable because the dates of Healthvana implementation were staggered in time.

Taking advantage of the sufficiently large sample size,[32] we used ordinary least-squares (OLS) regression models to evaluate the relationship between Healthvana implementation (pre-Healthvana vs post-Healthvana) and the mean number of days between STI test, notification, and treatment.

We also used Poisson regression models to evaluate the relationship between Healthvana implementation and the mean number of days between STI test, notification, and treatment. The Poisson regression models obtained robust SEs for the parameter estimates to control for violations of underlying assumptions.

The OLS regression model is the appropriate model if it is assumed that the effect of Healthvana on the outcomes was a reduction in time of a given number of days. The Poisson regression model is the appropriate model if it is assumed that the effect of Healthvana on the outcomes was a percentage reduction in the amount of time. Because there is no theory to guide this choice a priori, estimates for both models are reported.
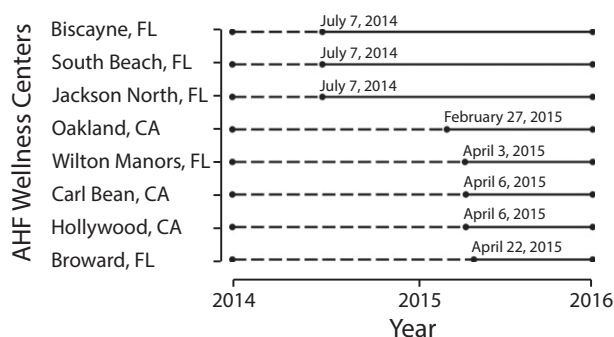


FIGURE 1—Healthvana Smartphone Application Rolling Implementation Dates at AIDS Healthcare Foundation (AHF) Wellness Centers: California and Florida, 2014 and 2015

In both models, we applied cluster-robust SEs to correct for nonindependence of observations within AHF Wellness Centers. We conducted all analyses in Stata version 14.2 (Stata Corp, College Station, TX).

## RESULTS

Among the 917 AHF Wellness Center clients, 424 (46%) were tested before Healthvana and 493 (54%) were tested after Healthvana (Table 1). Most of these clients (pre- and post-Healthvana) were younger than 25 years, self-identified as White or African American, and self-identified as not Hispanic or Latino. Fifty-three percent self-identified as heterosexual before Healthvana compared with 62% after Healthvana. After Healthvana, most (91%) of the clients opted to receive their STI test results via Healthvana.

## Mean Number of Days

Table 1 includes the mean number of days between test, notification, and treatment. In addition, Figure 2 displays the number of days between test and notification before versus after Healthvana. Pre-Healthvana clients experienced a mean of 8.13 days (95% confidence interval [CI] = 7.41, 8.84) from test to notification of STI test results, whereas post-Healthvana clients experienced a mean of 6.37 days (95% CI = 5.98, 6.76), which demonstrated a reduction of nearly 2 days (1.76) following Healthvana implementation (95% CI = −2.08, −1.43).

Pre-Healthvana clients experienced a mean of 3.54 days (95% CI = 2.85, 4.24) from notification to treatment and 3.78 days after Healthvana (95% CI = 3.12, 4.44), with an increase of one quarter of a day (0.24) following Healthvana implementation (95% CI = 0.20, 0.27). Lastly, we found that pre-Healthvana clients experienced a mean of 11.67 days (95% CI = 10.63, 12.70) from overall test to treatment, whereas post-Healthvana clients experienced a mean of 10.15 days (95% CI = 9.39, 10.91), which demonstrated a decrease of 1.52 days following Healthvana implementation (95% CI = −1.79, −1.24).

## Regression Models

Table 2 (and Appendix A, available as a supplement to the online version of this article at http://www.ajph.org) reports the findings from the OLS regression model, which found that Healthvana implementation was associated with a mean reduction of 3 days (coefficient = 3.07) from test to notification (P = .008; 95% CI = −5.05, −1.09), a mean increase of less than 1 day (coefficient = 0.71) from notification to treatment (P = .501; 95% CI = −1.67, 3.10), and an overall mean reduction of a little more than 2 days (coefficient = 2.36) from overall test to treatment (P = .127; 95% CI = −4.14, 0.57). In the Poisson regression model (Table 2; Appendix B, available as a supplement to the online version of this article at http://www.ajph.org), Healthvana implementation was associated with a 34% reduction in the mean number of days from test to notification (P < .001; 95% CI = 0.54, 0.81), a 5% increase in the mean number of days from notification to treatment (P = .850; 95%

TABLE 1—AHF Wellness Center Client Demographic Characteristics Before and After Healthvana Smartphone Application Implementation: California and Florida, 2014 and 2015

| Predictor Variables | Before Healthvana (n = 424), No. (%) or Mean (95% CI) | After Healthvana (n = 493), No. (%) or Mean (95% CI) | P (χ² test) |
|---|---|---|---|
| Age category, y | | | .4 |
| < 25 | 161 (37.97) | 201 (40.77) | |
| 25–29 | 113 (26.65) | 135 (27.38) | |
| 30–39 | 82 (19.34) | 87 (19.68) | |
| > 39 | 68 (16.04) | 60 (12.17) | |
| Race | | | .65 |
| White | 209 (49.29) | 252 (51.12) | |
| Asian | 24 (5.66) | 20 (4.06) | |
| Black/African American | 182 (42.92) | 208 (42.19) | |
| Other[a] | 9 (2.12) | 13 (2.64) | |
| Ethnicity | | | < .001 |
| Not Hispanic/Latino | 324 (76.42) | 322 (65.31) | |
| Hispanic/Latino | 100 (23.58) | 171 (34.69) | |
| Sexual orientation | | | .004 |
| Heterosexual | 223 (52.59) | 306 (62.07) | |
| MSM | 201 (47.41) | 187 (37.93) | |
| AHF Wellness Center | | | < .001 |
| Biscayne, FL | 22 (5.19) | 66 (13.39) | |
| Broward, FL | 177 (41.75) | 247 (50.10) | |
| Carl Bean, CA | 15 (3.54) | 10 (2.03) | |
| Hollywood, CA | 103 (24.29) | 50 (10.14) | |
| Jackson North, FL | 13 (3.07) | 35 (7.10) | |
| Oakland, CA | 31 (7.31) | 11 (2.23) | |
| South Beach, FL | 24 (5.66) | 51 (10.34) | |
| Wilton Manors, FL | 39 (9.20) | 23 (4.67) | |
| Notification type | | | < .001 |
| Telephone | 424 (100.00) | 45 (9.13) | |
| Healthvana | 0 (0.00) | 448 (90.87) | |
| Mean no. days | | | |
| Test to notification | 8.13 (7.41, 8.84) | 6.37 (5.98, 6.76) | |
| Notification to treatment | 3.54 (2.85, 4.24) | 3.78 (3.12, 4.44) | |
| Overall test to treatment | 11.67 (10.63, 12.70) | 10.15 (9.39, 10.91) | |

*Note.* AHF = AIDS Healthcare Foundation; CI = confidence interval; MSM = men who have sex with men. The sample size was n = 917.
[a]American Indian/Alaska Native and Native Hawaiian/Pacific Islander are both included in "Other" because of small sample sizes.
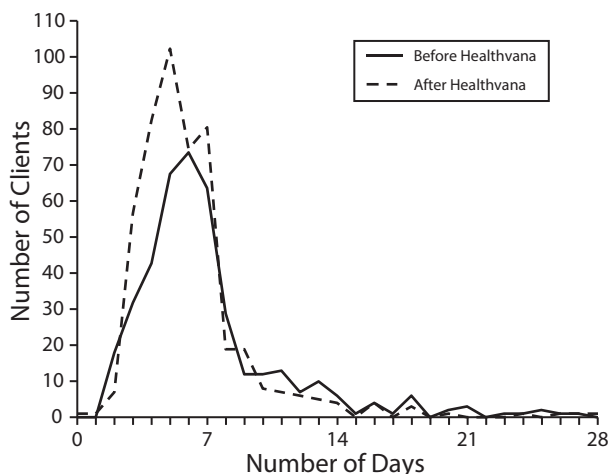
*Note.* AHF = AIDS Healthcare Foundation.

**FIGURE 2—AHF Wellness Center Client Number of Days From Test to Notification in Healthvana Smartphone Application: California and Florida, 2014 and 2015**

CI = 0.65, 1.68), and an 18% reduction in the mean number of days from overall test to treatment (*P* = .072; 95% CI = 0.66, 1.02).

To highlight some of the statistically significant findings in the Poisson regression model (Appendix A), clients who self-identified their race as "Other" experienced a time from test to notification that was 6% less than for clients who self-identified their race as White (*P* = .026; 95% CI = 0.73, 0.98). In addition, clients who self-identified their ethnicity as Hispanic or Latino experienced a time from test to notification that was 12% less than for clients who self-identified their ethnicity as not Hispanic or Latino (*P* = .024; 95% CI = 0.79, 0.98). Lastly, the Poisson regression model found a large number of statistically significant differences in all of the time outcomes across the 8 AHF Wellness Centers. For example, compared with Biscayne, every AHF Wellness Center experienced a decrease in the mean number

of days from test to notification, except Jackson North, which experienced an increase (12%) in the time from test to notification following the implementation of Healthvana (*P* < .001; 95% CI = 1.08, 1.17).

## DISCUSSION

Our study included a cross-sectional analysis of male clients who were tested, notified, and treated for STIs at AHF Wellness Centers between January 1, 2014, and December 31, 2015. We used OLS and Poisson regression models to measure the association of Healthvana implementation with the number of days from STI test to notification, from notification to treatment, and from overall test to treatment. Healthvana implementation status did not take into account whether a client opted in to receive their STI test results via Healthvana; rather, we were

interested in whether the overall implementation of Healthvana at each AHF Wellness Center was associated with a reduction in the number of days from STI test to notification, notification to treatment, and overall test to treatment. In this sense, our study addressed a health services question of the impact of Healthvana adoption in a clinic on the outcomes of their clients. As an intent-to-treat analysis, we did not analyze the impact of the use of the smartphone application itself.

In the Poisson regression model, Healthvana implementation was significantly associated with a nearly one third reduction in the mean number of days from test to notification and an 18% reduction in the days from overall test to treatment. Although the days from overall test to treatment did not achieve conventional statistical significance, it would have been incorrect to assume there was no effect.[33] The mean number of days from notification to treatment was not statistically significant; however, this was not surprising, because once clients received their test results—whether via Healthvana or telephone call—returning to an AHF Wellness Center for treatment was a health services issue that was not directly addressed by Healthvana.

The decrease in the mean number of days from test to notification was encouraging for AHF and Healthvana. Although these were observational data, our analysis used a strong, natural experimental design, exploiting within-clinic variation and controlling for differences across AHF Wellness Centers and across time in the outcomes. Although our study was not a randomized control trial, the effect of Healthvana was supported by the statistical design of the study. Through the fixed-effects analysis, each AHF Wellness Center, in effect, served as its own

**TABLE 2—Estimated Adjusted Association of Healthvana Smartphone Application Implementation: California and Florida, 2014 and 2015**

| Variable | Coefficient/IRR (95% CI) | | |
| --- | --- | --- | --- |
| | Test to Notification | Notification to Treatment | Overall Test to Treatment |
| OLS model coefficient: additional no. days after Healthvana | −3.07 (−5.05, −1.09) | 0.71 (−1.67, 3.10) | −2.36 (−4.92, 0.21) |
| Poisson model IRR: ratio of days relative to before Healthvana | 0.66 (0.54, 0.81) | 1.05 (0.65, 1.68) | 0.82 (0.66, 1.02) |

*Note.* CI = confidence interval; IRR = incidence rate ratio; OLS = ordinary least squares. Both models control for age, race, ethnicity, sexual orientation, AIDS Healthcare Foundation Wellness Center, and elapsed days from test to notification/treatment. The sample size was n = 917. (Full results are provided in Appendices A and B, available as supplements to the online version of this article at http://www.ajph.org.)

control, so any attributes particular to either clinics or to the panel of clients within clinics were statistically controlled. In addition, the staggering of implementation of Healthvana allowed the analysis to control for any secular effects over time. The use of an intent-to-treat analysis also eliminated the effect of client-level selection in who opted in to Healthvana. The remaining variation in the outcomes could be attributed to either only the effect of Healthvana or to other, un-observed variables that did not vary system-atically across clinics, across time, or between groups of clients who either chose Healthvana or did not choose Healthvana.

## Limitations and Strengths

There are several limitations to take into consideration. First, only clients who were successfully notified and returned for treat-ment were included in the analysis. There-fore, there might be differences between the study population and the clients who were excluded from analysis because they were either not notified of their positive STI results or did not return for STI treatment. Second, risky sexual behavior data would likely en-hance the analysis of our study, but such data were not available; by contrast, omission of these predictor variables might not likely detract from the present results.

There are several strengths in the findings of our study. Our study represents the first quantifiable analysis of the impact of Health-vana on client services for AHF, which is timely as Healthvana moves forward with streamlining AHF Wellness Centers' electronic medical records. In addition, AHF Wellness Centers are spread out across the United States; it is rare to be able to evaluate STI testing clinics that offer standardized care with the potential to improve STI services on a national level.

## Conclusions

Because of the proliferation of smart-phones in the United States, future research might find value in formally evaluating Healthvana and other smartphone applica-tions as tools to reduce STI–related disparities. According to a 2017 Pew Research Center report, 92% of people aged 18 to 29 years, 72% of African Americans, and 75% of Latinos own smartphones in the United States.[34] Overall, smartphone ownership has increased

from 35% in 2011 to 77% in 2016.[34] Ulti-mately, smartphone-based interventions should offer researchers opportunities to ensure high-risk populations, such as young African American men who have sex with men, engage in STI-related services.[35]

One of the long-term advantages of Healthvana is that its most compelling and engaging features—interactivity and personalization—are scalable. Once an STI testing clinic establishes an electronic medical record database for its clients, the clinic is virtually free to engage new clients. This en-gagement can be programmed to be repetitive, varying in form or intensity with time, or to be tailored based on STI-related disparities, such as age, race/ethnicity, gender, sexual orientation, or geographical location. More-over, smartphone applications like Healthvana are an ideal candidate for continuous quality improvement because the effects of minor changes on response times or other forms of engagement can be rigorously evaluated. Once a refined and effective smartphone application has been developed in one context, it can even more cheaply be adopted, or subsequently modified, in a different health promotion or disease prevention context.

The prompt notification by Healthvana of positive STI test results might help reduce disparities among AHF Wellness Center cli-ents who are most at-risk for STI acquisition simply because those clients who are other-wise difficult to reach are more likely to own smartphones and might be responsive to STI test results via the Healthvana smartphone application. In addition, the notification services of Healthvana may be able to assist in improving regular STI testing behaviors (e.g., quarterly reminders to get tested) and ulti-mately reduce the further spread of STIs. **AJPH**

### CONTRIBUTORS
A. C. Cohen conducted the statistical analyses and wrote the article. F. Zimmerman assisted with statistical analyses and edited the article. M. Prelip assisted with the article. D. Glik was the principal investigator for the study.

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