

Chatbot-based Intervention for Education and Access to at-home COVID-19 Testing in the SCALE-UP II Trial: a Descriptive Log Analysis Study

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Abstract

Background: Promoting at-home tests (e.g., for COVID-19) using chatbots may be a novel and scalable way to improve uptake across diverse populations.

Objective: The objective of this study was to assess patients' navigational patterns (i.e., sequence of interactions) when using a chatbot designed to provide education on COVID-19 testing and to order free at-home COVID-19 test kits.

Methods: The study was a secondary analysis of the SCALE-UP II trial, which compared different digital health strategies (i.e., chatbots versus simple text messages) to deliver free at-home COVID-19 test kits to minority populations in Utah. We analyzed chatbot usage logs to understand user behavior.

Results: Of 1,051 patients randomized to the chatbot intervention, 309 (29%) launched the chatbot and 196 (63%) interacted with it. Among those who interacted, 170 (87%) completed a test kit order. One patient (0.3%) accessed the chatbot educational content.

Conclusions: Ordering of COVID-19 test kits among patients who interacted with the chatbot was high. Patients placed orders without reviewing educational content. Chatbot design should minimize the number of steps for patients to achieve a goal.

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Original Manuscript

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Abstract

Background:

Promoting at-home tests (e.g., for COVID-19) using chatbots may be a novel and scalable way to improve uptake across diverse populations.

Objective:

The objective of this study was to assess patients' navigational patterns (i.e., sequence of

interactions) when using a chatbot designed to provide education on COVID-19 testing and to order free at-home COVID-19 test kits.

Materials and Methods:

The study was a secondary analysis of the SCALE-UP II trial, which compared different digital health strategies (i.e., chatbots versus simple text messages) to deliver free at-home COVID-19 test kits to minority populations in Utah. We analyzed chatbot usage logs to understand user behavior.

Results:

Of 1,051 patients randomized to the chatbot intervention, 309 (29%) launched the chatbot and 196 (63%) interacted with it. Among those who interacted, 170 (87%) completed a test kit order. One patient (0.3%) accessed the chatbot educational content.

Discussion and Conclusion:

Ordering of COVID-19 test kits among patients who interacted with the chatbot was high. Patients placed orders without reviewing educational content. Chatbot design should minimize the number of steps for patients to achieve a goal.

Background

During public health crises (e.g., the COVID-19 pandemic), early detection and management is central to crisis response.¹ Public health management seeks to avoid, mitigate, and control the negative impact of public health threats, especially in populations at risk for poor outcomes due to health inequities.^{2,3} Accurate and timely health education along with access to at-home COVID-19 testing may be instrumental in educating and empowering the public to assess personal risks, act in accordance with public health recommendations, and make decisions to protect themselves and those in their sphere of interaction.⁴

Digital health interventions such as text messaging and chatbots are promising approaches for

providing health education and creating a mechanism to provide access to at-home testing.^{5, 6} Chatbots are computer programs designed to simulate human conversation.^{7, 8} Systematic reviews have shown that interventions using chatbots are effective for a wide range of clinical problems, including treatment and monitoring, health services support, diagnostics, education, and lifestyle and behavioral change.⁹ Chatbots can reach users where health care is limited and offer a range of benefits such as convenience, scalability, personalization, and ease of use controlled by the patient.¹⁰ According to a scoping review, several chatbots were developed during the COVID-19 pandemic to provide information, personal risk assessment and triage, exposure notification and monitoring, and infection tracking.¹¹ For example, Perez-Ramos et al. found that a COVID-19 chatbot to be a feasible strategy to provide COVID-19 vaccine information and access to historically marginalized groups.¹² However, previous studies have not investigated the use of chatbots to reach individuals from historically marginalized groups to promote and deliver at-home COVID-19 testing.

The objective of this study was to assess patients' navigational patterns (i.e., sequence of interactions) when using a chatbot designed to provide education on COVID-19 testing and to order free at-home COVID-19 test kits. The study consisted of secondary analyses of SCALE-UP II, a pragmatic randomized controlled trial that investigated different digital health interventions promoting access to at-home COVID-19 testing among patients who receive care at low resource community health centers (CHCs) across the state of Utah.⁶ The trial was registered on clinicaltrials.gov (NCT05533359).

Methods and Procedures

Study Population

Study population was a subset of the SCALE-UP II trial population, including individuals who were randomized to the chatbot arm and opened the chatbot at least once during the course of the trial, from December 19, 2022 to August 28, 2023. The inclusion criteria for SCALE-UP II was 18 years of age or older, had English or Spanish as the preferred language recorded in the electronic health

record (EHR), had a valid cellphone number recorded in the EHR, and received care at one of 12 clinics within 3 safety net CHCs in Utah. Participating CHCs serve over 39,000 patients per year; 46% of patients are Hispanic/Latino, 54% uninsured, and three of the 12 clinics are located in rural areas. Rural or urban status was determined based on guidelines defined by the Federal Office of Rural Health Policy (FORHP).¹³

Chatbot content design

The chatbot used a scripted approach, with pre-defined content and navigational options. An interdisciplinary team of researchers with expertise in digital health, health communication, sociotechnical methods and biomedical informatics met on a weekly basis to discuss the design of the chatbot script. Chatbot script design was guided by health communication theories such as the extended parallel process model (EPPM);¹⁴ recommendations from sources including the US Centers for Disease Control, Utah Department of Health and Human Services, and COVID-19 test kit product manufacturers; and formative interviews and surveys with members of the target population. The resulting script started with an introduction explaining how to use the chatbot (Figure 1a), followed by a brief explanation about testing along with the option to order a test (Figure 1b) or to review educational content (Figure 1d). Educational content included topics such as (1) why, when, and how to use a test; (2) COVID-19 symptoms; and (3) what to do if a test is positive (e.g., quarantine, when and where to find treatment). Patients who placed an order were asked to confirm their mailing address available in the clinic's EHR (Figure 1c). If the address was incorrect, the patient had the opportunity to correct it (Figure 2). The chatbot software tracked detailed user interactions with timestamps through an audit log, which is the source of the data used for this study. Patients randomized to the chatbot arm of the trial had previously confirmed they had a smartphone and were able launch the chatbot by clicking a hyperlink sent via a text message on behalf of the patient's clinic (Figure 2).

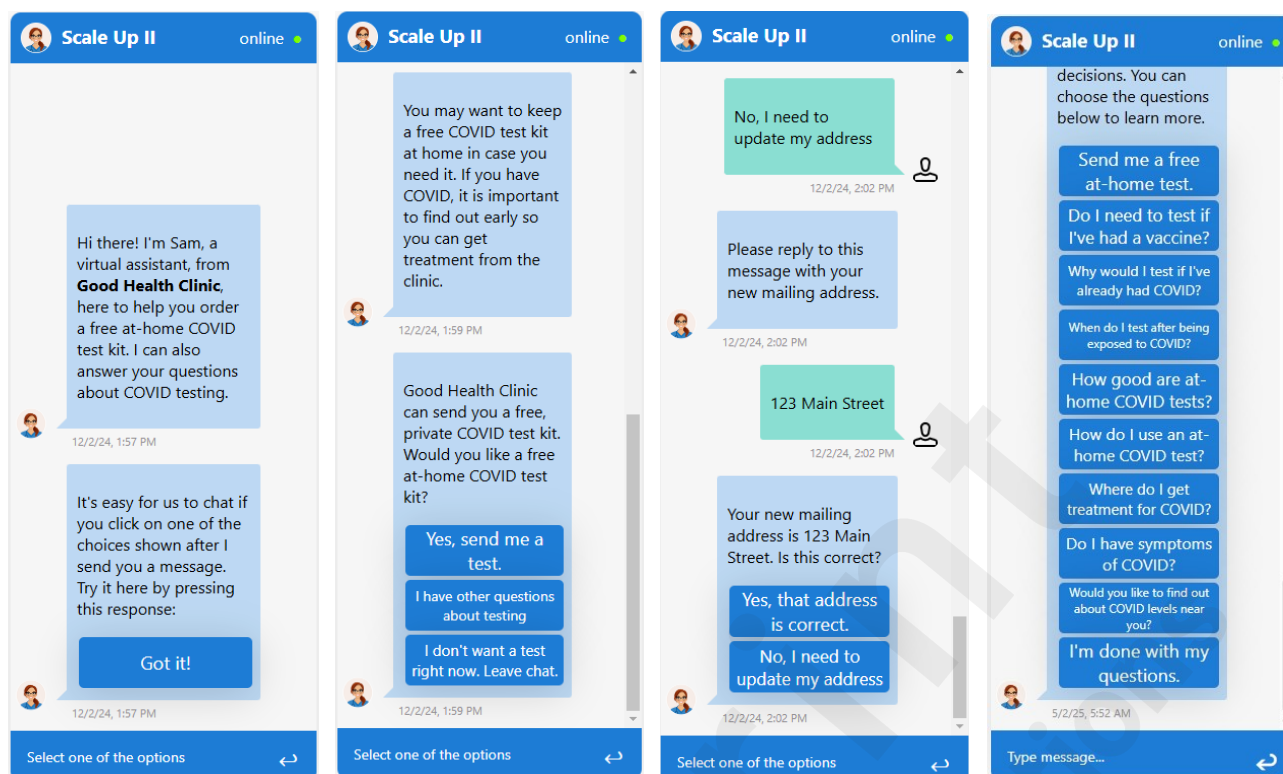


Figure 1. Chatbot interaction screenshots. (1a) Introduction; (1b) Test offer and option to review education content; (1c) Address verification; (1d) Educational topics.

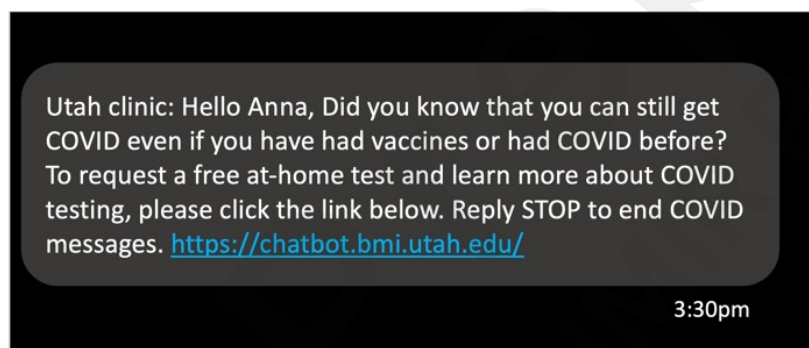


Figure 2. Text message screenshot with a hyperlink to launch the chatbot.

Data cleaning and processing

Chatbot log data were exported as comma-separated files (CSV) files and then cleaned for analysis. All cleaning and analyses were performed within a Python Jupyter notebook using Python (version 3.12.7), with Pandas (version 2.2.2) and NumPy (version 2.0.0). Chatbot log data were linked with demographic data from CHC EHRs. Next, chatbot navigation events were classified into two

overarching navigational categories: test ordering steps (i.e., starting a test order, address confirmation, address correction) and use of educational content.

Data analysis and interpretation

Descriptive statistics included time spent interacting with the chatbot, and counts and frequencies of chatbot navigation events.

Ethics

This study was approved by the University of Utah Institutional Review Board (IRB) under protocol number IRB_001156.

Results

Among the 1,051 patients randomized to the chatbot intervention in SCALE-UP II, 309 (29%) opened the chatbot at least once and were included in the chatbot log analysis study. Table 1 describe the demographics of study participants (N=309). The median age of patients was 51 years (range 18 to 90), 204 (66%) were female, 108 (35%) identified as Non-Latino White, 166 (54%) identified as Latino, 147 (48%) indicated Spanish as their preferred language in the EHR, 267 (86%) lived in an urban area and 170 (55%) were uninsured.

Table 1. Study population demographics.

N	309
Age (in years)	
<i>Mean (SD%)</i>	51 (15%)
Sex, No. (%)	
<i>Female</i>	204 (66%)
<i>Male</i>	104 (34%)
<i>Unknown</i>	1 (.3%)
Race/Ethnicity, No. (%)	
<i>American Indian/Alaska Native</i>	1 (.3%)
<i>Asian</i>	1 (.3%)

<i>Black/African American</i>	2 (.6%)
<i>Hawaiian/Pacific Islander</i>	1 (.3%)
<i>Hispanic or Latino/a</i>	166 (54%)
<i>Multi-race</i>	3 (.9%)
<i>White</i>	244 (79%)
<i>Unknown</i>	28 (11%)
Urban vs. Rural, No. (%)	
<i>Urban</i>	267 (86%)
Language, No. (%)	
<i>English</i>	149 (48%)
<i>Spanish</i>	147 (48%)
<i>Other</i>	4 (1%)
<i>Unknown</i>	9 (3%)
Insurance type. (%)	
<i>Private</i>	78 (25%)
<i>Public</i>	61 (20%)

Of the 309 patients who launched the chatbot, 186 (60%) started a test kit order, and 170 (55%) completed the test order. Of 34 (11%) patients who reported their address was not correct, 24 (8%) updated their address. One patient explored the educational content (Figure 3).

Navigation with the chatbot

Among 309 patients who launched the chatbot, 113 (37%) never interacted with the chatbot beyond the brief introduction explaining how to use the chatbot. Among the 196 patients who interacted with the chatbot, 186 (95%) started a test order and 170 (87%) completed the ordering process.

Among patients who interacted with the chatbot, the median session time was 70 seconds for those who started a test order versus 113 seconds among those who did not order (mean = 135 sec vs. 337 sec). Among those who started a test kit order, the median session time was 83 seconds for those who did not complete the order (i.e., did not confirm or correct their address) and 66 seconds for those who completed the order (mean = 136 sec vs. 135 sec).

COVID-19 at home test ordering process

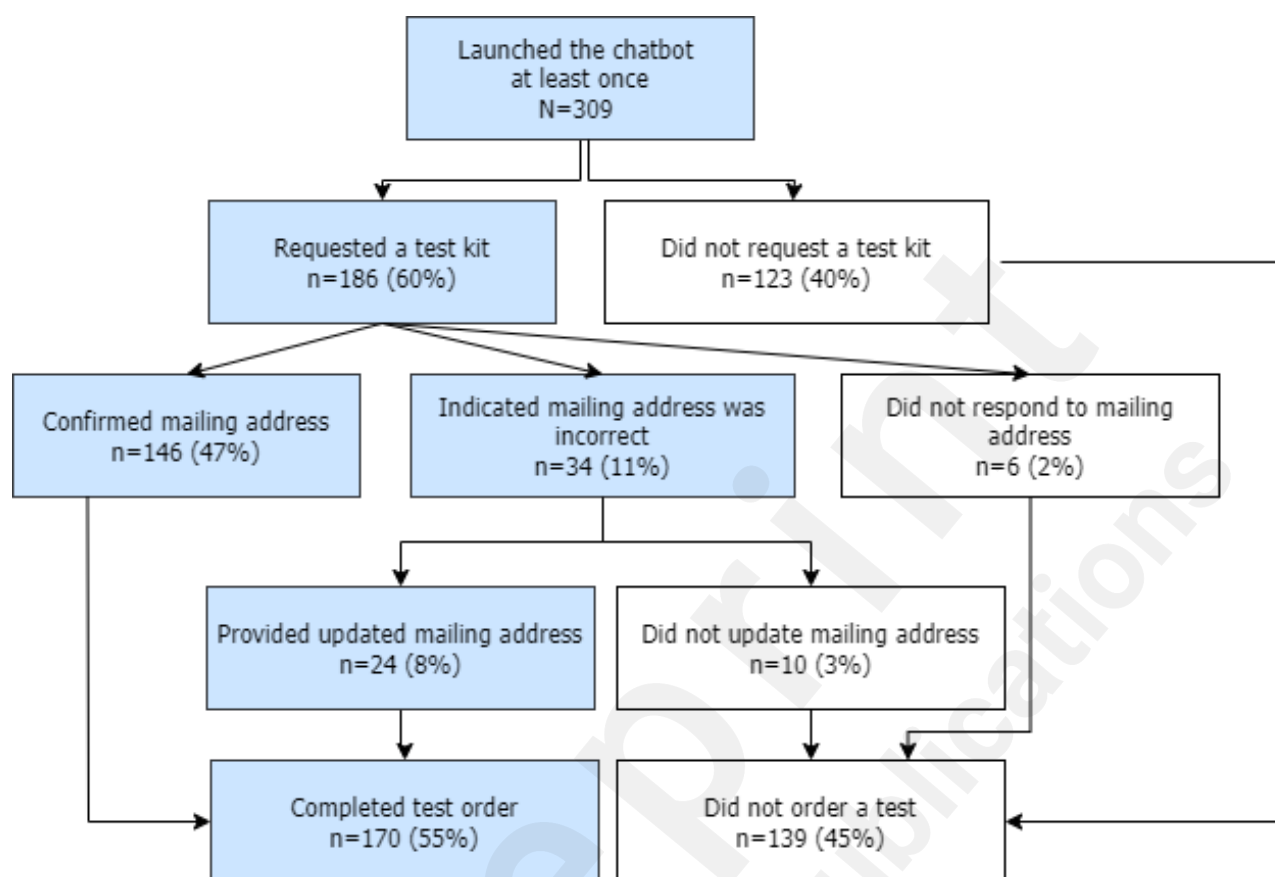


Figure 3. COVID-19 at-home test kit ordering process

Discussion

Over half of patients (55%) who launched the chatbot completed the ordering process for a test kit, which is relatively high when considering other published studies evaluating chatbots for diagnostic testing. For example, in a trial that investigated chatbots for genetic testing of familial cancer, 31% of patients launched the chatbot and 26% completed pre-test genetic test education.¹⁵ Another randomized controlled trial compared a digital health intervention using WhatsApp messenger versus usual care for colorectal cancer screening using fecal immunochemical tests (FIT). Test pick up and completion rates increased from 59.3% to 80.3% and 57.3% vs. 79.9% respectively.¹⁶

Only one patient accessed educational content, which may indicate that information needs were low and felt to be not necessary prior to ordering a test. This is consistent with behavioral economics as

patients exhibited expediency in obtaining a free at-home COVID-19 test.¹⁷

Given the study timing in relation to the course of the pandemic, prior exposure to other sources of information may have led to reducing and shifting patients' perceived information needs about COVID-19 testing.¹⁸ By December 2022 when the SCALE-UP II trial was launched, education campaigns had saturated both broadcast and social media channels, school and community venues, and clinical settings.^{19, 20} A high level of information saturation may have influenced the interest level in the COVID-19 educational content as the public began to exhibit COVID-19 messaging fatigue and information overload.^{20, 21} According to Sun et al., COVID-19 social media messaging fatigue was found to increase COVID-19 message avoidance.²²

Implications for chatbot design

A sizable portion of patients (37%) who launched the chatbot never interacted beyond the brief introduction explaining how to use the chatbot. On the other hand, the vast majority (87%) of those who interacted past the brief introduction completed a test kit order. It is possible that the brief introduction became a barrier to interaction and caused attrition. Therefore, chatbot design should consider minimizing the number of steps needed for patients to achieve a goal.

The timing of outreach via chatbots for the delivery of educational content should be explored in future studies. Furthermore, information needs and communication goals require independent consideration when determining the scope of a chatbot design. If deemed appropriate, a pre-test chatbot could offer brief educational content such as a short video explaining the benefits of testing, followed by the ordering workflow. Educational content could also be offered via chatbot after a patient receives a test kit to explain how to use a test and what to do if a test result is positive.

Limitations

This study offers important insights into navigational patterns of a chatbot intervention but also has limitations. First, the study findings reflect chatbot use patterns at a specific point in the context of a

pandemic. Consequently, it is possible that the study findings will not generalize to other public health contexts such as at the inception of a pandemic or routine preventive care testing, such as cancer screening. Furthermore, the COVID-19 pandemic became highly politicized and plagued by mis/dis/mal information.²³⁻²⁶ More research targeting other at-home testing scenarios (e.g., cancer screening, other infectious diseases) should be undertaken. Second, log data reflects user behavior, however it does not inform as to the motivation for the behavior. Due to the pragmatic design, the SCALE-UP II trial did not collect individual patient characteristics beyond demographics that may drive these behaviors. However, we were able to look at use of the chatbot in a population context. Last, the study population reflects historically marginalized populations in Utah and may not generalize to populations in other geographic locations.

Conclusion

This study found that a chatbot-based intervention resulted in a relatively high rate of ordering of at-home test kits for COVID-19 among those who interacted with the chatbot. All but one patient who ordered test kits did so without engaging with optional educational chatbot content. Chatbot design should minimize the number of steps for patients to achieve a goal.

Conflicts of interest

The authors declare no competing interests.

Funding

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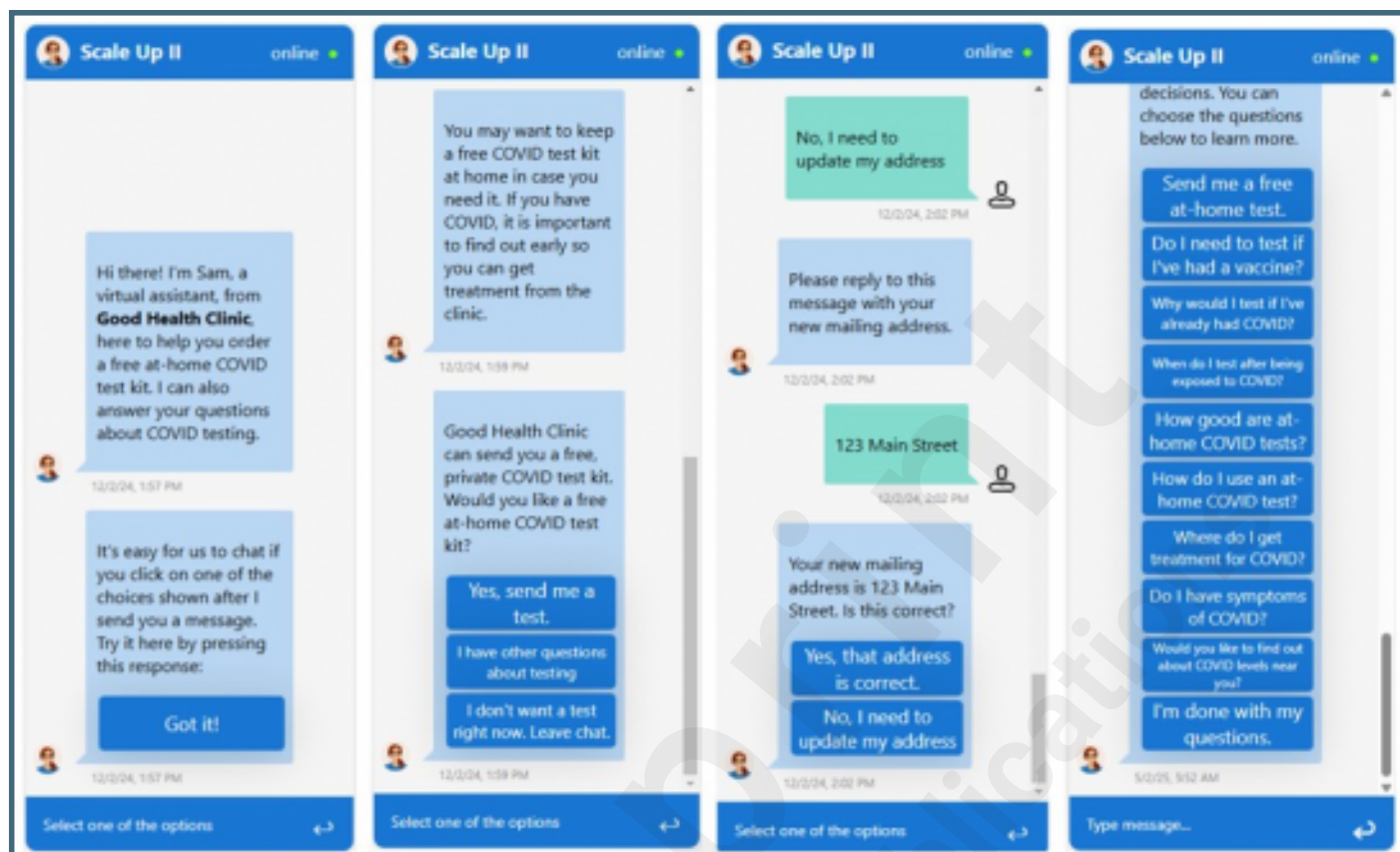
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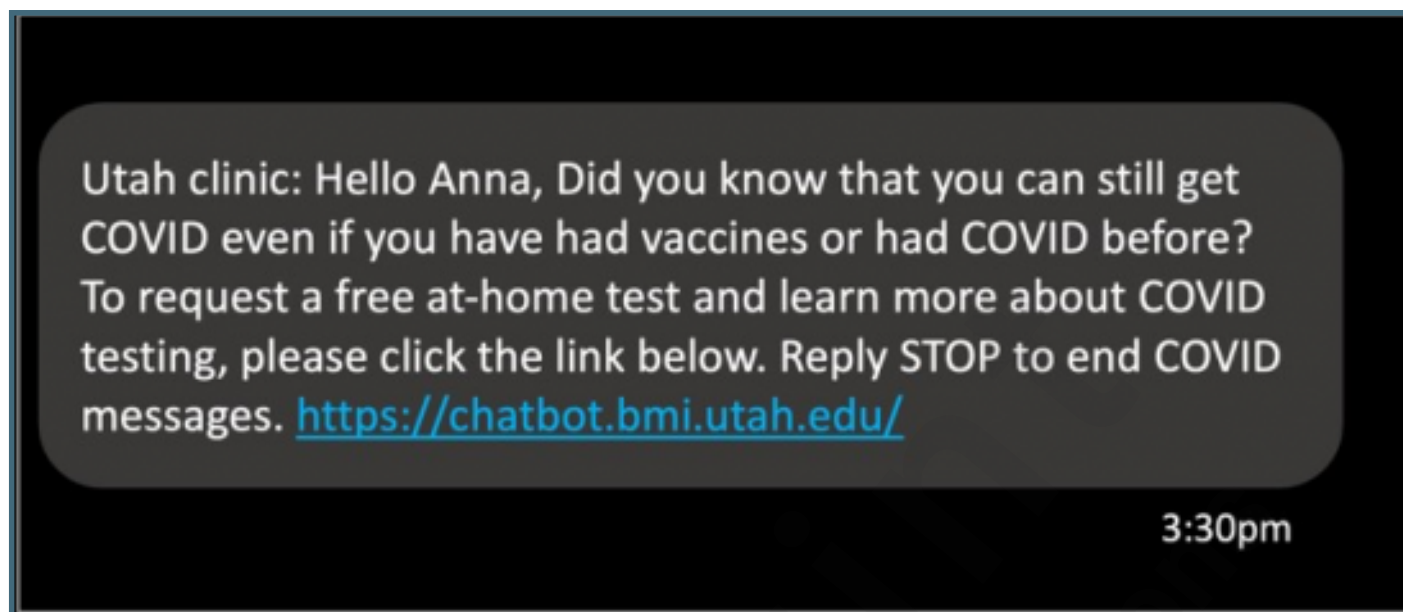
Supplementary Files

Figures

Chatbot interaction screenshots.



Text message screenshot with a hyperlink to launch the chatbot.



COVID-19 at-home test kit ordering process.

