



Text-Based Intervention Increases Mammography Uptake at an Urban Safety-Net Hospital

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ABSTRACT

Background. The low mammography rates at the authors' safety-net hospital (SNH) are associated with higher rates of late-stage disease. Previously, they showed that a phone call-based intervention with reminder and scheduling components significantly increased mammography uptake by 12% in their population, but implementation was resource-heavy. This study analyzed whether a text-based intervention with reminder and scheduling components could increase mammography uptake at 3 months compared with usual care.

Methods. This randomized controlled study analyzed 1277 women ages 50 to 65 years who were overdue for a mammogram but had established care at a primary-care clinic within an urban SNH. The patients received intervention 1 (a text reminder with specific scheduling options), intervention 2 (a text reminder with open-ended scheduling options), or usual care (control). Differences in the percentage of mammography uptake at 3 months were compared between the intervention and control groups using a two-tailed chi-square test.

Results. The patients receiving a text-based reminder and scheduling opportunity were significantly more likely to receive mammograms within 3 months than those in the usual-care control group (10.2% vs 6.2%; $\chi^2 = 5.6279$;

$p = 0.03$). In the intervention group, 10.3% of the participants scheduled an appointment for a mammogram via text, and 63% of these participants received a mammogram. Finally, mammography compliance did not differ by the type of scheduling offered (specific vs general) or by primary care clinic.

Conclusions. Leveraging technology for reminders and scheduling via two-way text messaging is effective in increasing mammography uptake in an urban safety-net setting and may be used as part of a multi-tiered intervention to increase breast cancer screening in a safety-net setting.

Breast cancer clinical stage at diagnosis is an important prognostic indicator of survival, with 5-year survival rates ranging from 100% for those with a tumor-node-metastasis (TNM) stage 0 or 1 diagnosis, 72% for those with a TNM stage 3 diagnosis, and 22% for those with a TNM stage 4 diagnosis.¹

At our urban, safety-net hospital in Kansas City, Missouri, we see an almost threefold higher rate of stages 3 and 4 breast cancers at diagnosis compared with other Commission on Cancer (CoC)-accredited sites across the country. A multiple regression analysis assessing the socioeconomic and biologic factors associated with later-stage diagnoses for our safety-net hospital (SNH) population found a lack of screening mammography within the 2 years before diagnosis to be the most significant factor ($p < 0.0001$; odds ratio [OR], 7.3; confidence interval [CI], 3.4–15.8).²

Compliance with biennial screening mammography at our internal medicine primary care clinics for women age 50 years or older is significantly lower (42%) than either the national average (71%) or the rate of Healthy People 2020 (81%).³ This disparity results in an intensifying disadvantage to SNH patients, especially amid the compounding effects of the Covid-19 pandemic that disproportionately affected SNH populations.⁴ As such, efforts have been made to increase mammography uptake, with the goal of attenuating breast cancer mortality in this at-risk population.

A randomized controlled study at our SNH showed that facilitating mammogram appointments using a phone call-based intervention significantly increased mammography uptake by 12% compared with those receiving usual care 3 and 6 months after intervention.⁵ In this study, scheduling was the critical component in increasing uptake. Although a phone call-based intervention was successful at increasing mammography uptake in this hard-to-reach population, it was costly and placed a significant burden on human resources. Implementing this finding on a system-wide basis proved to be challenging and resource-heavy. Thus, we aimed to leverage technology to achieve a similar outcome of increasing access to mammography.

Prior studies have shown success with text message reminders in increasing mammography uptake among low-income populations, but no study has evaluated the utility of scheduling by text.^{6,7} Because the use of text messaging services offers an opportunity for scaling the phone-based intervention in a more efficient and cost-effective way, we sought to determine whether a text-based reminder and opportunity for scheduling was successful in this cohort, and whether open-ended scheduling or discrete-option scheduling was more effective.

The primary outcome was mammography uptake 3 months after intervention compared with a usual-care control group. The secondary outcome measures were whether uptake differed by type of text (specific vs open-ended scheduling prompts), rate of interaction with the platform, rate of scheduling, or compliance with scheduling, and whether outcomes differed by clinic. We hypothesized that our text-based scheduling intervention would be effective in increasing mammography uptake at 3 months. We did not expect uptake to differ by clinic or by type of scheduling offered.

PATIENTS AND METHODS

Study Population

Any woman between the ages of 50 and 65 years who had not undergone a screening mammogram in the 2 years

before the study start date and who was established in an internal medicine primary care clinic at our SNH was eligible for inclusion. Patients were defined as established in the primary care clinics if they had been seen by the clinic at least once in the preceding 3 years.

The internal medicine clinics at our SNH follow the U.S. Preventive Services Task Force (USPSTF) recommendations of biennial mammographic screening starting at the age of 50 years. Hence, that was the age at which our patients were deemed to be due or overdue for mammograms for the purposes of this study.⁸

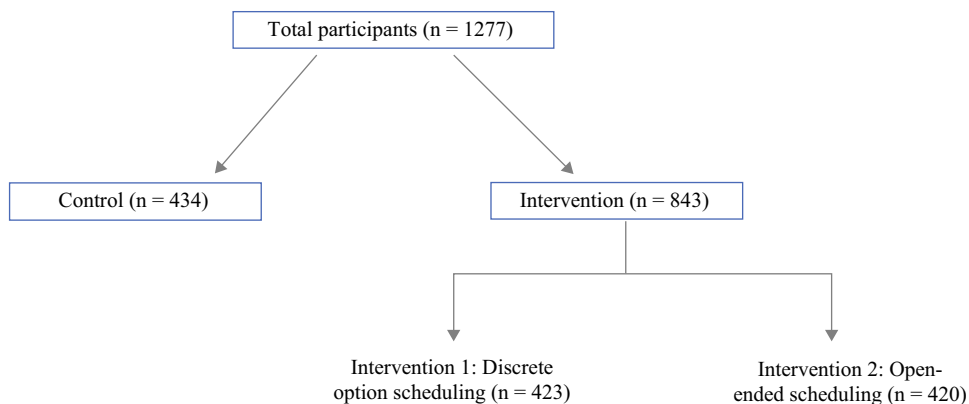
Although most women older than 65 years would have a life expectancy longer than 10 years and would thus be eligible for continued biennial mammograms, the age of the participants in this study was capped at 65 years to minimize any possibility of a mammogram recommended through the study for a patient with life span-limiting comorbidities when one was not actually recommended by her doctor. This was particularly pertinent given that the patients' primary care physicians were not aware of the study and we therefore did not want to give contradicting information to patients.

Study Design

This was a randomized controlled study approved by the University of Missouri-Kansas City School of Medicine Institutional Review Board and deemed to be exempt/nonhuman subjects research. The electronic medical record (EMR) was queried separately for each of the five primary care clinics at our SNH to determine which female patients ages 50 to 65 years had not undergone a screening mammogram in the preceding 2-year period. Across all five clinics, 2129 patients were identified as due for biennial mammography screening.

Randomization to the intervention or usual-care control group took place by clinic so each clinic would be represented proportionate to the number of mammogram-overdue women within it. From each clinic, 20% of the patients due for a mammogram were randomized to each of the two intervention groups, and 20% were randomized to the usual-care control group, for a total of 1277 women included in the study (intervention 1 for 423 patients, intervention 2 for 420 patients, and control group for 434 patients) (Fig. 1).

Randomization was performed by a random-number generator. The study excluded participants who were incorrectly included (i.e., not overdue for a mammogram because they had received a mammogram just before the query took place but before the intervention began). To maintain an intention-to-treat analysis, the patients with incorrect numbers or non-working numbers were included in the final analysis. Neither the physicians nor the medical

FIG. 1 Schematic of study design

staff within the primary care clinics were aware of the study, thus allowing usual care to proceed per routine.

Intervention

Before the intervention design was finalized, a pilot study was conducted to determine which of five text-messaging presentations (representing a range of discrete and open-ended scheduling options, including scheduling via the patient portal) was most effective (Table 1). Each text message was sent up to three times, with 1 to 2 days between each. The end point for the pilot study was the percentage of patients who scheduled mammograms within 1 week after receiving the last text message.

The pilot presentation with the highest scheduling success was determined to be intervention 1 (discrete scheduling, limited options) of pilot 3, with 21% success. Because pilot 2 (discrete scheduling, multiple options) and pilot 4 (open-ended, flexible style) were tied at 10%, we chose the open-ended scheduling, flexible style of pilot 4 for intervention 2 because it provided a contrast to the discrete scheduling we were already testing in intervention 1. In this way, we could secondarily compare effectiveness of discrete options versus open-ended messaging options when using text-based scheduling in our safety-net population.

The participants in both intervention groups could engage in two-way texting. Each participant in the intervention cohort received a maximum of three text messages before the attempt to contact was discontinued. Initial texts were sent by a research assistant via the Punctil messaging system, which was linked to the EMR. Responses to texts and completion of scheduling via EMR was performed by a breast clinic nurse navigator and radiology technologist.

Statistical Analysis

This was an intention-to-treat analysis. The primary outcome of mammography uptake 3 months after intervention was determined by direct chart review for both cases and controls. All the patients were included in the primary outcome analysis whether they were successfully reached by text message or not. Differences in percentage of mammographic uptake between groups were calculated using a two-tailed chi-square test, with a p value lower than 0.05 considered significant. Data were analyzed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Secondary analyses were performed to better understand differences between responders and non-responders, as well as other factors associated with mammography compliance. We sought to observe whether mean age differed between the responders and non-responders, whether those due for their first mammograms (age 50–52 years) differed from those overdue for screening (age > 52 years) in rate of response to the text message, and whether the time elapsed between scheduling and date of mammogram appointment affected compliance. We also sought to observe whether mammography uptake differed by primary care clinic. Finally, we analyzed our data for percentage of response to each of the three text messages to ascertain whether repeated text message presentations made a difference and to what degree.

Differences in the mean of continuous variables were calculated using the two-tailed t test, whereas differences in categorical variables were calculated using Fisher's exact/chi-square test, SAS version 9.4 (SAS Institute).

TABLE 1 Text-messaging options evaluated by pilot study together with percentage of mammograms scheduled

	0%	Scheduled
<p>Pilot 1 (<i>n</i> = 20)</p> <p>Scheduling via patient portal</p> <p>This is a message from Truman Medical Center. You are due for a screening mammogram. We care about your health and want to make it easier for you to take care of yourself. You can schedule a screening mammogram through your patient portal, or can set up a patient portal, here: betterforeveryone.iqhealth.com</p>		
<p>Pilot 2 (<i>n</i> = 20)</p> <p>Discrete text-based scheduling, multiple options</p> <p>This is a message from Truman Medical Center. You are due for a screening mammogram. We care about your health and want to make it easier for you to take care of yourself. The following appointments are currently available. To reserve a mammogram slot, please REPLY with the number of your preferred option: (1) Wednesday April 7th at 8:45 a.m.; (2) Wednesday April 7th at 11:15 a.m.; (3) Wednesday April 7th at 3:15 p.m.; (4) Thursday April 8th at 8:15 a.m.; (5) Thursday April 8th at 10:45 a.m.; (6) Thursday April 8th at 2:45 p.m. You will receive a confirmation once the appointment is confirmed</p>	10%	Scheduled
<p>Pilot 3 (<i>n</i> = 19)</p> <p>Discrete text-based scheduling, limited options (intervention 1)^a</p> <p>This is a message from Truman Medical Center. You are due for a screening mammogram. We care about your health and want to make it easier for you to take care of yourself. Please REPLY 1 if you would like to have your mammogram on Wednesday April 7th at 8:45 a.m. or REPLY 2 if you would like your mammogram on Wednesday April 7th at 3:15 p.m. You will receive a confirmation once the appointment is confirmed. If neither of these times work for you, please reply by text with the day and time that works best for you or call 816-xxx-xxxx for more information and assistance with scheduling</p>	21%	Scheduled
<p>Pilot 4 (<i>n</i> = 20)</p> <p>Open, flexible scheduling (intervention 2)^a</p> <p>This is a message from Truman Medical Center. You are due for a screening mammogram. We care about your health and want to make it easier for you to take care of yourself. Please REPLY YES if you would like to receive a call back to schedule this or call 816-xxx-xxxx for more information and assistance with scheduling</p>	10%	Scheduled

^aThe two options/wording ultimately chosen as interventions 1 and 2

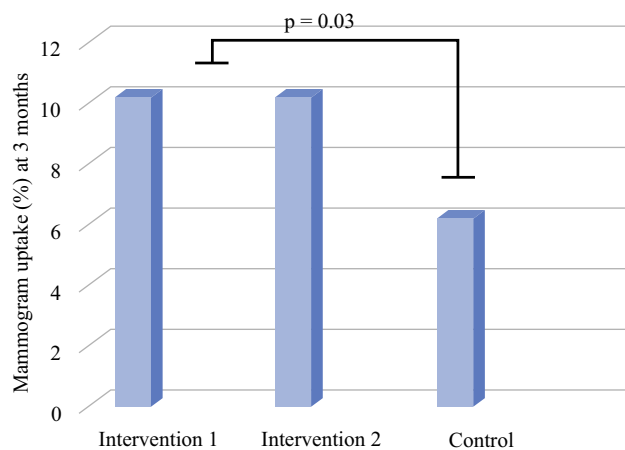


FIG. 2 Bar graph showing percentage of mammography uptake at 3 months for patients who received an open-ended text-based scheduling opportunity (intervention 1, 10.2%), discrete text-based opportunity (intervention 2, 10.16%), and usual care (control subjects) (2%)

RESULTS

Primary Outcome

The patients who received a text-based reminder and scheduling opportunity were significantly more likely to receive mammograms within 3 months than those in the usual-care control group (10.2% vs 6.2%; $\chi^2 = 5.6279$; $p = 0.03$), Fig. 2. Of the 1277 participants, 14.8% responded to the text messages, and 10.3% scheduled an appointment for a mammogram via text, with 63.2% of these patients following through and receiving a mammogram. This was consistent with prior studies showing that scheduling is critical to the success of access-enhancing interventions.

Secondary Outcomes

Mammography compliance did not differ by type of scheduling offered (specific vs open-ended). Mammography uptake at 3 months was 10.2% for open-ended scheduling (intervention 1) and 10.16% for discrete-options scheduling (intervention 2). Mammography uptake at 3 months did not differ by primary care clinic. The six clinics included in the study had respective compliance rates of 8.1%, 12%, 10.3%, 11.9%, 10.1%, 8.5% in their intervention groups combined.

The responders to text messages were slightly younger than the non-responders overall (56.4 vs 57.4; $p < 0.05$, two-tailed t test), but this differed by type of text intervention. Specifically, mean age did not differ between the responders and non-responders to the more open-ended intervention 1 (56.9 vs 57.4; $p = 0.86$), but the responders

were slightly younger than the non-responders (56 vs 57.4 years; $p < 0.05$) in intervention 2, which presented more discrete scheduling options. We furthermore found no difference in response to text messages by age category (50–52 vs >52 years; $\chi^2 = 0.3$; $p = 0.85$).

Among those who scheduled mammograms, the days elapsed from scheduling to appointment date did not differ between those who actually underwent the mammograms and those who did not show up for the scheduled mammograms (mean, 12.8 vs 13.3 days; $p = 0.78$). In analyzing the effect of repeated text messages, we found that 69.74% of those who responded and scheduled an appointment replied after one text, whereas 30.26% of those who responded and scheduled an appointment replied after two texts. None of the patients who replied after three texts ended up scheduling an appointment.

DISCUSSION

Previously, we showed that a phone-based intervention with a scheduling component significantly increased mammography uptake among our safety-net patients.⁵ In this study, we demonstrated that reminders and scheduling via two-way text messaging resulted in significantly increased mammography uptake compared with usual-care control subjects in the same population. Furthermore, we established that discrete-option messaging is as effective as open-ended messaging when text-based scheduling is used. This finding tended toward the idea that clinicians may use knowledge of open radiology slots when it is advantageous. Clinicians can likewise present open-ended options when these are more advantageous.

Most prior studies using text messaging to improve screening did so by way of reminders.^{6,7,9} Two studies found that text and mail letter reminders increased screening rates, whereas another study found text reminders to be more effective for screening compliance than informational brochures alone.^{9–11} One of these studies used texting to reschedule appointments and did not find it advantageous in the population studied.⁹ To our knowledge, ours was the first study to use two-way text messaging both to remind patients of overdue status and as a scheduling tool.

Although only 15% of our patients due or overdue for mammograms interacted with the two-way text messaging system, 63% of the patients who did schedule their mammograms via texting kept their mammogram appointment. This was higher than the 47% follow-through rate observed in our prior study when patients were scheduled after a phone call.⁵ This suggests that a subset of patients accessing care at SNHs respond well to text-based scheduling and demonstrate good follow-through.

Although this is not the panacea for mammography compliance, we suggest that this is a critical and significant population of patients for whom this intervention clearly works. It is notable that the usual-care control rate of mammography for a 3-month period during this study in 2021 was 6%, which is identical to the rate of mammography uptake among our usual-care control subjects in our prior 2019 study.⁵

In trying to better distinguish responders from non-responders, we did a few secondary analyses with available data. We examined the impact of age on responsiveness to scheduling by text in two ways: by comparing mean differences between responders and non-responders and by categorizing and comparing women ages 50 to 52 years with those older than 52 years. We expected to find younger patients more likely to engage with text-messaging platforms than older patients due to the assumption that the young have greater familiarity with technology. We did find that, on the average, the responders were 1 year younger than the non-responders, as were the responders to the discrete-option text messages. We did not think that this difference of 1 year was particularly clinically relevant or actionable. When we categorized age and compared our youngest women (age 50 to 52 years) with those older than 52 years, we did not find a difference. This could have been confounded by the fact that for some patients 50 to 52 years of age, this would have been their first mammogram, whereas for others older than 52 years, this may have been a repeated mammogram or could have been a first mammogram. In the future, studying other demographic variables and extracting more data on prior mammograms may give more insight into who is most likely to respond to text-based scheduling within the safety-net population.

We next analyzed whether the interval between the text response/scheduling and the actual mammogram appointment date differed between the 63% of patients who actually followed through and the 37% who did not show for the appointment. We did not find any difference in the interval from text to appointment between the two groups, with an average 13-day interval in both.

Prior studies have shown that same-day mammography increases compliance.¹² Although this is offered theoretically at our safety-net hospital, it does not function in practice. Because our need greatly exceeds our mammogram capacity, the patients who do show up for same-day appointments face wait times that easily exceed 1 h. Thus, utilization of same-day mammograms is not a common choice in practice at our safety-net hospital.

The primary limitation of this study was its focus on a single institution without any test of its generalizability. However, we hope that it can offer insight into the value of access-enhancing facilitation of mammogram scheduling via two-way text messaging for SNH populations across

the country. The strength of this study was its randomized controlled design and its intention-to-treat analysis, which limited bias and confounders, simulating real-world scenarios as closely as possible.

Our text-based intervention leverages technology to reduce the burden on human resources that a phone-based intervention requires. However, texting is less effective than a phone-based intervention, with an absolute 4% increase in mammography uptake versus usual-care control in this study, compared with 12% in our previous study.⁵

The predominant advantage of texting is reduction of cost and time for an already-strained health care system. Calling patients to schedule appointments places extra responsibility on clinical staff or requires hiring additional personnel. Moreover, the messages sent via text are simple and easy to interpret, which is valuable for patients with low health literacy. Although this specific study sent text messages in English only, implementing a similar intervention with text messages in a patient's preferred language is a reasonable next step because women who prefer non-English languages also were found to have lower rates of mammography.¹³

Although the impact of our intervention was significant, our post-intervention mammography rates still were lower than national averages and the goal of Healthy People 2020. This suggests that more than one strategy will be needed to eliminate the disparity observed in our SNH. Early studies of women with historically lower rates of screening confirm that interventions using multiple strategies are more effective than interventions using a single strategy.^{14,15} Because texting reminders and scheduling for mammograms are less labor intensive for an institution than phone call reminders, it is plausible to use a two-tiered intervention: first offering scheduling options to patients via text message and then following up with a phone message to those who do not interact with or schedule by text. In fact, a large implementation study currently is underway within our safety-net hospital using data gained from this study to do just that: patients who are overdue for a screening mammogram will be presented with two reminders and an opportunity to schedule via text. In our study, a third text message did not increase compliance. The patients who still do not schedule mammograms through text messaging will receive phone calls in a manner similar to the method in our prior study.⁵

Safety-net patients have multiple and often complex needs, but leveraging technology via two-way texting can be used to increase mammogram rates in this hard-to-reach population, most likely as part of a multi-intervention strategy.

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