

Using Health Text Messages to Improve Consumer Health Knowledge, Behaviors, and Outcomes

An Environmental Scan



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Abstract

Background and Objectives

The rapid expansion of mobile health (mHealth) programs through text messaging provides an opportunity to improve health knowledge, behaviors, and clinical outcomes, particularly among hard-to-reach populations. To support future efforts by the U.S. Department of Health and Human Services (HHS) related to text messaging programs specifically and mHealth initiatives more broadly, this environmental scan reviews the current landscape on the effectiveness and acceptance of health text messaging programs. This environmental scan examines the technology context related to cell phone ownership and text messaging use, current evidence on the effectiveness and acceptance of text messaging interventions, and implications for future research and program implementation.

Methods

This environmental scan includes studies on the effectiveness and acceptance of health text messaging interventions published between January 2009 and October 2012, including seven systematic reviews and a synthesis of evidence from the Agency for Healthcare Research and Quality (AHRQ) Health Care Innovations Exchange. The scan focuses on individual-level interventions in the United States and other high-resource countries. The scan excludes studies of interventions that had been implemented primarily in developing countries or that targeted only system-level interventions (such as those aimed at the physician workforce or hospital administrative systems).

Results

A substantial body of research has shown that health text messaging programs can bring about behavior change to improve short-term smoking cessation outcomes as well as short-term diabetes management and clinical outcomes (increasing frequency of blood glucose monitoring and reducing HbA1c levels). Research has also shown that text messaging improves treatment compliance, including both medication adherence and appointment attendance. Research suggests that text messaging can improve immunization rates, increase sexual health knowledge, and reduce risky behaviors related to HIV transmission, although the literature is less definitive in these areas.

Conclusions

With the recent proliferation of health text messaging applications in the United States, emphasis should be placed on addressing gaps in knowledge about the effectiveness and acceptance of health text messaging programs. Future efforts should include (1) conducting an ongoing environmental scan of the field, (2) performing systematic reviews of new research and sharing lessons learned, and (3) determining the reach of text messaging programs, particularly among underserved populations. In addition, future research should focus on assessing long-term outcomes of text messaging interventions.

The trends toward wide spread ownership of cell phones and widespread text message use across virtually all segments of the U.S. population will continue to support the spread of health text messaging programs. This scan provides encouraging evidence related to the use of health text messaging to improve health promotion, disease prevention, and disease management.

Introduction

The rapid expansion of mobile technology infrastructure presents an opportunity to improve health and health care through new forms of interactive mobile health (mHealth) services that promote personal wellness, preventive care, and disease management. Recognizing the potential of text messaging programs to improve health and health care, the U.S. Department of Health and Human Services (HHS) established a Text4Health Task Force in November 2010 to identify existing initiatives and recommend strategies to promote the development, implementation, evaluation, and coordination of health text messaging programs in the United States.

Table 1 highlights seven HHS text messaging initiatives that are under way (or under development) to address various health issues. These initiatives represent a mix of approaches: some offer applications that provide text messages directly to consumers who sign up, while others offer libraries containing evidence-based text messages that state or local agencies or health professionals can use in their own text messaging programs. Two common features of current text4health initiatives are cross-agency federal collaboration and public-private partnerships. The Task Force recommended that HHS develop evidence of the effectiveness of health text messaging programs through formal evaluations of current and future initiatives (HHS 2011). The task force recommendations are available at <http://www.hhs.gov/open/initiatives/mhealth/recommendations.html>.

Despite a high level of activity and interest in mHealth applications and programs, documented evidence of their effectiveness remains limited (Boncana 2013; Cole-Lewis and Kershaw 2010; Mehl 2010; Nilsen et al. 2012; Sarasohn-Kahn 2010; Tamrat and Kachnowski 2012). However, recent evaluations of text messaging applications indicate their potential for supporting patient self-management by facilitating patient education, behavior change, and adherence to recommended care practices. For example, a systematic review of the literature on disease management and prevention services delivered through text messages found evidence to support text messaging as a tool for behavior change in eight of nine studies with sufficient sample sizes (Cole-Lewis and Kershaw 2010).

To support future HHS efforts related to health text messaging programs specifically and mHealth initiatives more broadly, this environmental scan reviews the current landscape on the effectiveness and acceptance of health text messaging programs. This environmental scan examines the technology context related to cell phone ownership and text messaging use, current evidence on the effectiveness and acceptance of text messaging interventions, and implications for future research and program implementation.

The environmental scan focuses on literature published between January 2009 and October 2012, including seven systematic reviews, and a synthesis of evidence from the Agency for Healthcare Research and Quality (AHRQ) Health Care Innovations Exchange. This report focuses on systematic reviews and the AHRQ Innovations Exchange because of their methodological rigor in (1) identifying relevant evidence against pre-specified inclusion and exclusion criteria, (2) assessing the rigor of the research design and the quality of evidence, (3) abstracting and synthesizing results, and (4) recognizing the study limitations. The report includes reviews that examined text messaging as a component of health promotion, disease prevention, or disease management programs and excludes reviews limited to evidence from developing countries (Gurman et al. 2012; Deglise et al. 2012). mHealth interventions in lower-resource countries operate within health system infrastructures fundamentally different from those in the United States and other high-resource countries (Sherry and Ratzan 2012; Uhrig et al. 2012).

Table 1. Selected Federal Text4Health Text Messaging Initiatives

Initiative	Type of Text Messaging Initiative	Focus	Description
Text4baby	Consumer Application	Maternal and Child Health	<p>Providing pregnant women and new mothers free health text messages in English or Spanish, including information and referral timed to the stage of pregnancy or age of the baby; involves a public-private partnership with National Healthy Mothers, Healthy Babies Coalition and Voxiva; since February 2010, more than 650,000 people have ever enrolled in Text4baby</p> <p>URL: http://www.text4baby.org</p>
TXT4Tots	Message Library	Child Health (Nutrition and Physical Activity)	<p>Providing a library of brief, evidence-based messages focused on nutrition and physical activity targeted to parents and caregivers of children ages 1 to 5, based on Bright Futures Guidelines, and available in English and Spanish; the messages can be disseminated through text messaging or incorporated in other programs</p> <p>URL: http://www.hrsa.gov/healthit/txt4tots/</p>
SmokeFreeTXT	Consumer Application	Tobacco Control	<p>Delivering 24/7 tips, motivation, encouragement, and advice about smoking cessation through text messages targeted to adults and young adults; the service is free, but message and data rates apply</p> <p>URL: http://smokefree.gov/smokefreetxt</p>
QuitNowTXT	Message Library	Tobacco Control	<p>Offering a library of free and publicly available interactive text messages for adults who are ready to quit smoking; includes a delivery algorithm with day-specific quit messages that provide tips, motivation, encouragement, and fact-based information; message content can be tailored according to user-specific keywords</p> <p>URL: http://smokefree.gov/hp.aspx</p>
SmokeFree Moms	Message Library	Tobacco Control	<p>Developing a library of free and publicly available text messages for pregnant women who wish to quit smoking; the messages will be personalized, interactive, and evidence-based</p> <p>URL: Release date anticipated Spring 2014</p>
Health Alerts On-the-Go	Consumer Application	Health and Safety	<p>Providing CDC's health and safety information on mobile devices, including seasonal flu, H1N1 flu, public health emergencies, and other topics</p> <p>URL: http://www.cdc.gov/mobile/</p>
Text Alert Toolkit	Message Library	Emergency Response and Preparedness	<p>Providing a text message library for emergency preparedness and response for voluntary use by state and local agencies can use during hurricanes and floods; future topics include chemical, biological, radiological, nuclear, and explosion messages</p> <p>URL: http://emergency.cdc.gov/disasters/psa/textmessages.asp</p>

Source: Adapted from [HHS.gov/Open](http://www.hhs.gov/Open), HHS Text4Health Projects. Available at <http://www.hhs.gov/open/initiatives/mhealth/projects.html>.

The Current mHealth Landscape

mHealth refers to the use of wireless technologies, such as cell phones, personal digital assistants, and netbooks, for improving health. Text4baby is one of many mHealth interventions around the world. A recent inventory counted nearly 400 mHealth projects in more than 100 countries.¹ In a global context, mHealth interventions are used to strengthen health care systems by improving emergency referrals for obstetric care, providing support to community health workers and midwives in remote locations, delivering health promotion services to patients, and supporting remote data collection by community health workers (Tamrat and Kachnowski 2012).

Cell phones are the most popular mobile device used in mHealth interventions. Distinct advantages offered by cell phones over other mobile tools include their relatively low cost, wide spread use, and on-board processing power to record, store, organize, and broadcast information in real time (Riley 2010). Basic cell phones leverage standard communication functions such as voice and text. The emergence of smart phones now offers more advanced multimedia functions such as video, web browsing, and health-related software applications.

Mobile technology's low start-up cost, text messaging capabilities, and flexible payment plans make it attractive for use in supporting a range of interventions. They can generally be classified into five categories that include both individual- and system-level interventions and that cover the continuum of care from health promotion/disease prevention to chronic disease management and emergency response (Mechael et al. 2010):

1. **Health promotion and disease prevention**, such as delivering health information and prevention messaging to promote healthy behaviors or referral to services
2. **Treatment compliance**, such as providing patient reminders to take drugs or attend medical appointments to improve management of asthma, diabetes, or HIV/AIDS
3. **Health information systems and point-of-care support**, such as offering clinical support for health professionals and community health workers through telemedicine
4. **Data collection and disease surveillance**, such as obtaining real-time data from community health workers, patient self-reports, or clinic and hospital records on disease outbreaks
5. **Emergency medical response**, such as maintaining alert systems that disseminate information in an emergency or during disaster management and recovery

The first two types of interventions are aimed at improving the health status of individuals, the latter three at improving health care systems. Most of them, regardless of whether they target the individual or the system level, use cell phone devices and widely adopted applications such as text messaging (also known as Short Messaging Service, or SMS). Text messages, which are limited to 160 characters, require attention to health literacy and cultural appropriateness for diverse populations (Tirado 2011).

¹ More information on mHealth projects is available at <http://www.mhealthworkinggroup.org/project>.

Health-related functions of text messaging interventions can include health behavior reminders, prompts to schedule or confirm an appointment, notification of a laboratory result or health status report, requests for data, encouragement to engage in positive behaviors, or information and resources to improve self-efficacy. The goal of these interventions is to promote efficiencies in care management practices and, ultimately, improve individual and population health outcomes.

Mobile technology is evolving beyond its initial focus on direct communication between providers and patients and one-way monitoring. Three trends are particularly noteworthy:

1. **Interactive.** Enabling the two-way flow of information that engages patients more actively in the management of their health (see Franklin et al. 2008, for an example)
2. **Integrated.** Integrating multiple disease self-management applications to share health information between patients and providers through text messages, centralized web-based programs to track and manage health data, and mobile monitoring (such as blood glucose monitoring) to promote treatment compliance and positive health behaviors (see Quinn et al. 2011, for an example). These interventions increasingly involve multiple components of the health care system more directly, including primary care providers, case managers, support staff, and of course, patients (Katz et al. 2012)
3. **Multimedia.** Increasing the use of games and quizzes in communicating health prevention messages and motivating behavior change (see Abrams et al. 2012, for an example)

The recent diffusion of smart phones may accelerate trends toward interactive (two-way) and multimedia communications to engage patients in behavior change, as well as the increasing integration of text messaging, email, audio/video, and Internet capabilities.

The mHealth Technology Context: Widespread Use of Cell Phones in the United States

Overview of Cell Phone Ownership

Cell phones represent a nearly ubiquitous technology infrastructure that is inexpensive, convenient, accessible, and easy to use. As of December 2012, there were 326 million wireless subscriber connections in the United States, with 2.2 trillion messages sent during 2012 (CTIA 2013). Cell phones are divided into three categories: (1) basic phones, with voice and text messaging; (2) feature phones, which are basic phones with camera and video capabilities; and (3) smart phones, which have advanced data-enabled communication capabilities, such as Internet access or a built-in Global Positioning System. In 2013, 91 percent of the U.S. population aged 18 and older owned a cell phone, and 56 percent owned a smart phone (Rainie 2013; Smith 2013). U.S. ownership of smart phones increased from 35 percent in 2011 to 46 percent in 2012 and 56 percent in 2013; smart phones are now more common than feature phones (Smith 2013). As shown in Table 2, the level of cell phone and smart phone ownership varies by household income and education level; for example, among adults who did not graduate from high school, 83 percent owned a cell phone and 36 percent owned a smart phone, compared to 95 percent and 70 percent, respectively, of college graduates. Not surprisingly, younger adults (aged 18 to 24) are more likely to own a cell or smart phone than those aged 65 and older.

Table 2. Demographics of Cell Phone and Smart Phone Users, 2013

Characteristics	Percentage of Teens Who Own a Cell Phone	Percentage of Teens Who Own a Smart Phone	Percentage of Adults Who Own a Cell Phone	Percentage of Adults Who Own a Smart Phone
Total	78	37	91	56
Gender	.	.	.	.
Male	77	36	93	59
Female	78	38	88	53
Age	.	.	.	.
12–13	68	23	n.a.	n.a.
14–17	83	44	n.a.	n.a.
18–24	n.a.	n.a.	97	79
25–34	n.a.	n.a.	97	81
35–44	n.a.	n.a.	96	69
45–54	n.a.	n.a.	92	55
55–64	n.a.	n.a.	87	39
65+	n.a.	n.a.	76	18
Race/Ethnicity	.	.	.	.
White, non-Hispanic	81	35	90	53
Black, non-Hispanic	72	40	93	64
Hispanic	64	43	88	60
Household Income	.	.	.	.
Less than \$30,000	69	39	86	43
\$30,000–\$49,999	74	24	90	52
\$50,000–\$74,999	81	38	96	61
\$75,000+	86	43	98	78
Education Level	.	.	.	.
Less than High School	NA	NA	83	36
High School Graduate	71	35	88	46
Some College	79	35	92	60
College+	87	41	95	70
Community Type	.	.	.	.
Urban	76	42	92	59
Suburban	81	39	91	59
Rural	73	19	85	40

Sources: Pew Research Center's Internet & American Life.

(1) Teen cell phone ownership (Madden et al. 2013). Available at http://www.pewinternet.org/~media/Files/Reports/2013/PIP_TeensandTechnology2013.pdf.

(2) Adult cell phone ownership (Rainie 2013). Available at <http://www.pewresearch.org/fact-tank/2013/06/06/cell-phone-ownership-hits-91-of-adults/>.

(3) Adult smart phone ownership (Smith 2013). Available at http://pewinternet.org/~media/Files/Reports/2013/PIP_Smartphone_adoption_2013_PDF.pdf.

Note: For teens, race/ethnicity, household income, and education level refer to parent characteristics. Education level for teens combines less than high school and high school graduate.

n.a. = not applicable; NA = not available

Use of Text Messaging

In 2013, the most common use of cell phones among adults (apart from voice calls) was text messaging: 81 percent of adult cell phone owners (74 percent of all adults) sent or received text messages (Duggan 2013). Texting was more common among smart phone owners (92 percent) versus other cell phone owners (59 percent) (Smith 2011). Use of text messaging declined with age: it was used by 97 percent of those aged 18 to 29 versus 35 percent of those 65 and over (Table 3). Rates also varied by race/ethnicity, with the highest among Hispanic adults (87 percent), followed by Black adults (85 percent), and White adults (79 percent). Within the Hispanic population, cell phone and smart phone ownership patterns mirror the general population, with variations by age and income. In addition, those who are foreign born had lower rates than those who are native born (Lopez et al. 2013). The Hispanic Institute and Mobile Future (2009) suggested that mobile phones have become more widely accessible because of new products and services aimed at lower-income people, such as pre-paid options; heavily subsidized smart phone offerings; and unlimited mobile text, phone, and data plans. One study estimated that Medicaid patients (79 percent) were more likely to use text messages than those who were privately insured (65 to 68 percent) and those with no insurance (63 percent) (Health Research Institute 2010).

Table 3. Demographics of Adult Cell Phone Owners Who Send and Receive Text Messages, 2013

Characteristics	Percentage of Adult Cell Phone Owners Who Send and Receive Text Messages
Total	81
Gender	.
Male	81
Female	81
Age	.
12–13	n.a.
14–17	n.a.
18–29	97
30–49	94
50–64	75
65+	35
Race/Ethnicity	.
White, non-Hispanic	79
Black, non-Hispanic	85
Hispanic	87
Household Income	.
Less than \$30,000	78
\$30,000–\$49,999	80
\$50,000–\$74,999	88
\$75,000+	88
Education Level	.
Less than High School	71
High School Graduate	77
Some College	85
College+	86
Community Type	.
Urban	82
Suburban	82
Rural	76

Source: Pew Research Center's Internet & American Life (Smith 2013). Available at http://pewinternet.org/~media/Files/Reports/2013/PIP_Cell%20Phone%20Activities%20May%202013.pdf.

n.a. = not applicable

Use of Internet and Health-Related Applications on Cell Phones

The percentage of adult cell phone owners in the United States using their phone to access the Internet increased from 31 percent in 2009 to 55 percent in 2012 and 63 percent in 2013 (Duggan and Smith 2013). Internet functions include sending and receiving email, instant messaging, accessing social networking sites, and watching videos, with younger and minority groups having the highest usage rates. Among Hispanic and Black adults, wireless Internet use rates are 68 percent and 74 percent, respectively, compared to 59 percent among White adults (Duggan and Smith 2013). Moreover, Hispanic and Black adults are more likely than White adults to use their cell phones as the primary means for web access and email (Duggan and Smith 2013).

Smart phones are increasingly important for the growth of mHealth, as evidenced by the rise in the development and use of health-related software applications (Ruder Finn 2013). These applications cover a wide variety of topics, including (but not limited to) preventive care, prenatal and well-child care, exercise and fitness, health education, chronic disease management, medication adherence and education, and physiological monitoring. In 2012, 31 percent of mobile phone owners used their smart phones to search for health-related information (up from 17 percent in 2010), while 19 percent had health-related applications on their phones (up from 9 percent in 2010) (Fox 2010; Fox and Duggan 2012). Those most likely to use their phones to search for health information were younger, Hispanic, college-educated, higher-income, and urban populations. English-speaking people were far more likely than Spanish-speaking people to have a health-related application on their phone (9 percent versus 1 percent).

Table 4. Use of Cell Phones to Look Up Health Information or to Manage Health, 2010

Characteristic	Percentage of Adults Who Used Their Cell Phone to Look Up Health Information	Percentage of Adults Who Had an “App” on Their Cell Phone to Help Them Track or Manage Their Health
Total Cell Phone Users	31	19
Gender	.	.
Male	29	16
Female	33	23
Race/Ethnicity	.	.
White	27	19
Black	35	21
Hispanic	38	15
Age	.	.
18–29	42	24
30–49	39	19
50–64	19	16
65+	9	10
Education Level	.	.
Some high school	17	NA
High school graduate	26	11
Some college	33	24
College graduate or more	38	22
Household Income	.	.
<\$30,000	28	14
\$30,000–\$49,999	30	21
\$50,000–\$74,999	37	21
\$75,000+	37	23

Source: Pew Research Center’s Internet & American Life (Fox and Duggan 2012). Available at http://pewinternet.org/~media/Files/Reports/2010/PIP_Mobile_Health_2010.pdf.

NA = not available

Cell Phone Ownership and Use by Gender

Cell phone ownership is slightly less common among women than men (88 versus 93 percent) and similarly, women are less likely than men to own a smart phone (53 versus 59 percent) (Rainie 2013; Smith 2013) (Table 2). Among cell phone owners, women and men are equally likely to send or receive text messages (81 percent each), access the Internet via their cell phone (59 percent of women and 62 percent of men) (Duggan 2013) or look for health or medical information online (33 percent of women and 29 percent of men), Women were more likely than men to have software applications on their phones to track or manage health (23 percent of women and 16 percent of men) (Fox and Duggan 2013). Women were also slightly more likely than men to receive health or medical information via text message (9 versus 6 percent) (Fox and Duggan 2013). In general, the data show that, among cell phone owners, there are slight differences in how women and men use their phones. The major difference is the frequency of owning a cell phone or smart phone to enable these uses.

Cell Phone Ownership and Use Among Teens

Cell phone ownership and usage is prevalent among youth aged 12 to 17 (Table 2). In 2012, 78 percent owned a cell phone and 37 percent owned a smart phone (Madden et al. 2013). The overall rate of cell phone ownership has not changed since 2009, but the rate of smart phone ownership has increased substantially from 23 percent in 2011 to 37 percent in 2013 (Madden et al. 2013). Not surprisingly, older teens were more likely than younger teens to own a cell phone (83 versus 68 percent). The rate of cell phone ownership was highest among White teens (81 percent) and lowest among Hispanic teens (64 percent), with Black teens in the middle (72 percent). Teens in the highest-income families were also more likely than those in the lowest income families to own a cell phone (86 versus 69 percent) (Madden et al. 2013). The majority (74 percent) of teens use a mobile device (cell phone or tablet) to access the Internet, and 25 percent use their cell phone as their primary source of access (Madden et al. 2013). Texting is the dominant mode of communication among teens, with 75 percent of all teens sending text messages, including 63 percent that say they text daily (in contrast, only 39 percent talk on the phone daily). The median number of text messages among teens was 60 per day; older girls ages 14-17 had a median of 100 texts a day in 2011, higher than any other group (Lenhart 2012).

Evidence on the Effectiveness of Health Text Messaging Programs

Evidence from Systematic Reviews

Systematic reviews are typically the “gold standard” for assessing evidence of the effectiveness of a technology or intervention. This report includes seven such reviews of the evidence related to the effectiveness of text messaging interventions on patient behaviors and health outcomes (Car et al. 2012; Cole-Lewis and Kershaw 2010; Fjeldsoe et al. 2009; Guy et al. 2012; Krishna et al. 2009; Vervloet et al. 2012; Whittaker et al. 2009). The seven systematic reviews included a total of 60 studies; 17 of the 60 studies were cited in more than one review. Table 5 summarizes the study designs, findings, and implications for future research for each of the seven systematic reviews.

The studies covered a range of health topics related to health promotion and disease prevention (such as weight reduction, physical activity, and smoking cessation) or disease management (most commonly, diabetes, but also asthma and hypertension). The Fjeldsoe et al. (2009) review included 14 studies and found positive behavior changes in 13, though only 8 had sufficient power to detect significant changes. Three of the 4 preventive interventions showed positive changes in smoking cessation, physical activity, or weight reduction, while 5 of the 10 clinical care programs showed improved HbA1c levels, metabolic control, or blood pressure control. In addition, the review suggested that programs that tailored message content to participants had lower attrition rates than those with untailored messages.

Table 5. Summary of Findings from Systematic Reviews on the Effectiveness of Text Messaging Interventions in Health Care

Authors (Year) Study Title	Background / Study Design	Key Findings	Implications for Future Research
Car, Gurol-Urganci, de Jongh, Vodopivec-Jamsek, and Atun (2012) Mobile Phone Messaging Reminders for Attendance at Healthcare Appointments	Systematic review of four randomized controlled trials (RCTs) of the effects of mobile phone messaging reminders on patients' attendance at health care appointments. Three studies were found to be moderate quality and one was low quality. Primary outcome was attendance at health care appointment. To be included, studies had to isolate the effects of mobile phone messaging reminders from other interventions.	Three studies showed that text message reminders improved attendance relative to no reminders. One study showed that a text message and mail reminder combined was more effective than a mail reminder alone. There was no difference in attendance rates between text message and phone message reminders. However, the cost of text message reminders was lower than the cost of phone message reminders. The authors concluded that the studies provided limited evidence of the effectiveness of text message reminders given the quality of the current studies.	Rigorous research is needed to measure health effects, costs, and cost-effectiveness, as well as patient and provider assessments of the interventions. Future research also should assess the content and timing of text messages in relation to the appointment.
Cole-Lewis and Kershaw (2010) Text Messaging as a Tool for Behavior Change in Disease Prevention and Management	Systematic review of 17 articles representing 12 studies using text messaging as the primary mode of communication for disease prevention and management. Of the 12 studies, 5 were for disease prevention (preventive medication adherence, weight loss, physical activity, and smoking cessation), and 7 were for disease management (one focused on asthma and the others on diabetes). Studies were randomized or quasi-experimental controlled trials published in peer-reviewed journals between 2005 and June 2009. One study had a sample size of 1,705, but others ranged from 16 to 126. Nine countries were represented (Austria, Canada, Croatia, Finland, France, New Zealand, Scotland, South Korea, and the United States).	Three of the 12 studies were not powered to detect a statistically significant difference in the primary outcome and therefore produced inconclusive results. Of the nine sufficiently powered studies, eight found evidence to support text messaging as a tool for behavior change (weight loss, smoking cessation, and diabetes management). Two studies found significant behavior change outcomes: (1) smoking cessation (at 6 and 12 weeks) and (2) increase in frequency of blood glucose monitoring and reporting via text message reminders. Six studies found significant clinical outcomes: (1) greater weight loss in obese adults at 4 and 12 months (two studies); and (2) greater decrease in HbA1c levels in adolescents and obese and non-obese adult diabetics (four studies). Two of the 12 studies isolated the effect of text messaging on clinical outcomes: one found that text message reminders increased the frequency of blood glucose monitoring when compared with email reminders; another found decreased HbA1c levels when compared with an Internet-based monitoring system.	Evidence about the use of text messaging to improve diabetes management is more advanced than other areas, suggesting the need for more rigorous trials in other areas. Future studies should specify a theory of change. In particular, prevention programs might achieve stronger results when content is developed based on theory. Future studies should ensure rigorous methods, sufficient power, and isolate the independent effect of the text messaging technology. Evidence on efficacy can also be obtained from nonrandomized trials (such as dose, message frequency, and message content). Additionally, future research should assess the long-term effects of text messaging interventions.

Table 5 (continued)

Authors (Year) Study Title	Background / Study Design	Key Findings	Implications for Future Research
<p>Fjeldsoe, Marshall, and Miller (2009)</p> <p>Behavior Change Interventions Delivered by Mobile Telephone Short-Message Service</p>	<p>Evidence review of health behavior change interventions using text messaging interventions published between January 1990 and March 2008; studies were required to assess health behavior changes using at least pre-post comparisons (a control group was not required); studies had to be published in peer-reviewed scientific journals.</p> <p>Fourteen articles (of 33 identified) met the inclusion criteria: 4 targeted preventive health behaviors (for example, smoking cessation), and 10 focused on clinical care (for example, diabetes self-management). Intervention length ranged from six weeks to one year.</p> <p>Six of the 14 studies were RCTs, 2 used other randomized trial designs, and 6 were single group, pre–post design studies. None of the studies collected follow-up data after the intervention ended. Sample sizes ranged from 10 to 1,705. Retention varied from 43 to 100 percent.</p>	<p>Positive behavior changes were observed in 13 of the 14 reviewed studies, although only 8 studies were sufficiently powered to detect significant, positive behavioral changes. Three of the four preventive interventions showed positive changes in smoking cessation, physical activity, and weight reduction. Five of the 10 clinical care programs showed improved HbA1c levels, metabolic control, or blood pressure control.</p> <p>The two studies that did not use tailored text message content were among the studies with the highest participant attrition. This finding may support the notion that untailored health messages are less engaging for participants than tailored messages.</p>	<p>More rigorous studies are needed, with larger sample sizes, measurement of behavioral outcomes post-intervention, and reporting of process measures and characteristics related to the text message intervention (such as number of messages sent/received, tailoring of message content). Use of objective and validated outcome measures ensures more accurate assessments.</p> <p>Future research should assess the effects of specific text message characteristics on outcomes to optimize and enhance interventions (such as recruitment/enrollment methods, tailoring of message content, and interactions between participants and researchers).</p>
<p>Guy, Hocking, Wand, Stott, Ali, and Kaldor (2012)</p> <p>How Effective Are Short Message Service Reminders at Increasing Clinic Analysis?</p>	<p>Meta-analysis and systematic review of 18 studies of the impact of text message reminders on clinic attendance rates. Most studies were in Europe, but also included Australia, Brazil, China, Malaysia, and the United States.</p> <p>Ten were observational studies and eight were RCTs. Because of heterogeneity in the observational studies, the meta-analysis was restricted to the eight RCTs.</p>	<p>Based on a meta-analysis of eight RCTs, appointment reminders using text messages increased the likelihood of appointment attendance by 50 percent compared with no appointment reminder. There were no differences by clinic type (primary care or hospital outpatient clinics), timing of the reminder message (24, 48, 72, or more hours before the appointment), or target age (pediatric, adult).</p>	<p>Future research should examine the clinical reason for the visit because it could influence the patients' priority for keeping the appointment (independent of the text message reminder). In addition, future research should examine the effect of visit status (new or follow-up) on visit attendance rates.</p>

Table 5 (continued)

Authors (Year) Study Title	Background / Study Design	Key Findings	Implications for Future Research
Krishna, Boren, and Balas (2009) Healthcare via Cell Phones	Systematic review of role of cell phones and text messaging in disease management. Findings based on 25 articles that met the inclusion criteria: controlled studies evaluating cell phone voice and text messaging interventions to provide medical reminders and disease management support. Reviews included 20 RCTs and 5 controlled studies. Nineteen studies assessed outcomes of care and 6 assessed processes of care across 12 clinical areas. Studies included 38,060 participants (10,374 adults and 27,686 children) in 13 countries.	<p>Twenty of the 25 studies reported significant differences between control and intervention groups as a result of cell phone and text messaging interventions regardless of the frequency of message delivery. A total of 101 processes and outcomes were measured in the 25 studies, of which 61 showed significant improvements among those receiving a cell phone–based intervention. Of the 19 studies that evaluated health outcomes, 16 reported changes in health outcomes. In addition, 8 of 10 studies reported behavior changes. Smoking cessation studies reported significantly greater success in behavior modification among the intervention group.</p> <p>Significant improvements in outcomes were found in medication adherence, asthma symptoms, HbA1c levels, stress levels, smoking cessation rates, and self-efficacy. Process improvements were found in: appointment attendance, diagnosis and treatment speed, and teaching and training.</p>	<p>Future studies should include larger sample sizes; 2 studies had fewer than 20 participants. The findings of these studies might not be generalizable to other populations.</p> <p>More studies should include cost information. Only two studies in this review provided such information.</p>
Vervloet, Linn, van Weert, de Bakker, Bouvy, and van Dijk (2012) Effectiveness of Interventions Using Electronic Reminders to Improve Adherence to Chronic Medication	Systematic review of 13 studies about interventions involving an electronic reminder (text message, audio/visual, or pager) to improve medication adherence among patients prescribed chronic medication. All studies were RCTs, and 4 of the 13 tested the effect of text messaging interventions. Seven were considered high quality studies (including the four text message studies) and six were low quality, based on criteria established for assessing the quality of evidence.	Of the 13 studies, 8 found significant overall effects of electronic reminders on patient medication adherence, including 3 of the 4 text messaging interventions. The three text message studies with significant findings were for HIV (two studies) and asthma. One of the studies included a personalized text message and required a reply from patients that they took the medication; the other 2 used standardized messages with no reply requested. The one study with no significant findings included daily text message reminders for oral contraceptives with no reply requested. The review concluded that text messaging interventions were particularly effective, compared with other types of reminders, influenced by patient willingness to receive text message reminders.	Future studies should investigate the influence of personalized versus standardized messages on adherence, and should include longer-term follow-up. Studies should also focus on the effectiveness with “unintentionally nonadherent” patients (those who are willing but forget or are inaccurate).

Table 5 (continued)

Authors (Year) Study Title	Background / Study Design	Key Findings	Implications for Future Research
Whittaker, Borland, Bullen, Lin, McRobbie, and Rodgers (2009) Mobile Phone-Based Interventions for Smoking Cessation	Systematic review of effectiveness of smoking cessation interventions; the primary outcome of interest was smoking cessation at six months or longer after enrolling in the intervention; included four randomized or quasi-randomized trials aimed at mobile phone users who were smokers, one in New Zealand, one in the United Kingdom, and two in Norway; all involved text messaging and the Norway trials included an Internet component; four studies were excluded because they were nonrandomized feasibility studies and two studies were excluded because the follow-up period was less than six months.	The meta-analysis found positive short-term (6 weeks) effects of mobile phone interventions on quitting smoking; the self-reported smoking abstinence rate (no smoking in the past 7 days) was higher after one month in the intervention programs compared with participation in the control programs. No consistent effect on long-term outcomes was found, in part due to methodological issues related to classification of outcomes; however, the intervention that combined Internet and mobile phone components was effective up to one year.	More rigorous studies of long-term outcomes are needed, with particular emphasis on reporting 6-month outcomes; use of self-reported cessation outcomes might be sufficient in studies with no face-to-face interaction with participants, especially adolescents (when anonymity is a key component of the intervention).

Sources: See reference list for full citations.

Cole-Lewis and Kershaw (2010) found evidence to support text messaging as a tool for changing behavior or improving clinical care outcomes in eight of the nine sufficiently powered studies they reviewed (three additional studies were not sufficiently powered). The authors noted that these changes were found across different ages, ethnicities, and nationalities. Significant behavior changes were found with respect to increased blood glucose monitoring and increased prevalence of non-smoking by smokers at 6 and 12 weeks. Significant clinical outcomes included greater weight loss among obese adults at two points (4 and 12 months) and greater decrease in HbA1c levels among diabetics. Several of the studies, however, did not isolate the effect of text messages on these outcomes. For example, the intervention that resulted in significant weight loss included personalized text and multimedia messages, monthly printed materials, and brief monthly phone calls with a health counselor (the control group received printed materials only) (Patrick et al. 2009). The study was not able to distinguish the independent effect of the text messages and the effect of message content and dosage. Specifically, the messages were personally tailored and interactive, and ranged from two to five a day, depending on personal preference; the user could also change the timing and frequency of messages. About half the messages requested a reply; if the user did not reply, the system would automatically adjust the number of messages requesting replies to minimize annoyance. The system also adjusted message content according to responses to questions.

Krishna et al. (2009) reviewed 25 studies that used either voice or text communication with cell phones, and found significant process or outcome improvements in 20. Significant behavior changes were observed in 8 of 10 studies, especially among people receiving smoking cessation interventions on their cell phones. In addition, all but one of the nine studies on diabetes-related health outcomes found significant improvement. The study concluded: "Chronic diseases such as diabetes and asthma, requiring regular management, as well as smoking cessation, requiring ongoing advice and support, benefited most from the cell phone interventions." The study found mixed evidence related to appointment attendance: in two of four studies reviewed, the delivery of a reminder between 1 and 3 days before a scheduled appointment resulted in significantly higher attendance rates among those receiving the reminders than among those not receiving them (attendance rates did not differ significantly in the other two studies).

In general, these reviews found strong evidence related to the impact of text messaging on improving diabetes self-management. For example, Cole-Lewis and Kershaw (2010) cited four studies that found greater decreases in HbA1c levels among those receiving text messages than those in the control group. One of these studies found a significant increase in the frequency of blood glucose monitoring and reporting via text message reminders compared to email reminders, while another found that text messaging was more effective in reducing HbA1c levels than an Internet-based monitoring system. Krishna et al. (2009) showed that HbA1c levels were improved in various studies that used cell phones for diabetes education and advice, insulin adjustments by a nurse based on input of information through text messaging, or text messaging support from a diabetes care professional.

Studies on the effect of text messaging on smoking cessation also generally showed positive and significant short-term effects (Whittaker et al. 2009; Cole-Lewis and Kershaw 2010; Krishna et al. 2009; Fjeldsoe et al. 2009). Whittaker et al. (2009) conducted a meta-analysis of four studies related to smoking cessation and found positive effects on short-term abstinence after 6 weeks. Few studies examined outcomes beyond 6 weeks (after the intervention ended) (Whittaker 2009). A more recent trial, however, demonstrated increases in smoking cessation rates at 6 months through the use of text message reminders in combination with behavioral support (Free et al. 2011).

Three systematic reviews assessed the effect of text messaging reminders on treatment compliance, specifically health care appointment attendance (Car et al. 2012; Guy et al. 2012) and medication adherence (Vervloet et al. 2012). These reviews concluded that text messaging of reminders significantly improved patient compliance. Guy et al. (2012) conducted a meta-analysis of eight randomized controlled trials (RCTs) that used text messages to provide appointment reminders, and found that reminders increased attendance rates by 50 percent, compared to no reminders. There were no differences by type of clinic, message timing, or target age group. Car et al. (2012) reviewed four studies and found that attendance rates were (1) higher with text message reminders than with no reminders; (2) higher in combination with a mail reminder than with a mail reminder alone; and (3) similar to a phone reminder. However, the text message reminder was less expensive than the phone reminder. Both reviews provide evidence of the value of text messaging to improve appointment attendance.

Of the 13 studies that assessed the effects of electronic reminders (text messages, audio/visual, or pager) on medication adherence, 4 included text message reminders, and 3 of the 4 were found to significantly improve adherence for HIV medication use (2 studies) and asthma medication use (one study) (Vervloet et al. 2012). Two studies provided personalized text messages and requested a reply when taking medication, while one used standardized text messages with no reply. The one study with no significant findings provided daily text message reminders for oral contraceptives and did not find a difference in the rate of missed pills between those who received a text message reminder and those who did not. The authors noted that the effective interventions varied in whether they used personalized versus standardized messages and whether they required a reply after taking the medication; they suggested that future research assess the influence of message content on patient behavior.

One of the challenges encountered in many of the trials cited in the systematic reviews was the continued engagement of participants in the intervention. Fjeldsoe et al. (2009) found that retention rates varied widely, ranging from 43 percent to 100 percent across the 14 studies. Cole-Lewis and Kershaw (2010) found that retention ranged from 68 percent to 100 percent across the five disease prevention studies (median was 95 percent), and from 73 percent to 100 percent across the seven disease management studies (median was 98 percent). The study with a 73 percent retention rate highlights the challenges of behavior change interventions using new technologies (Hanauer et al. 2009). Forty insulin-treated diabetic patients aged 12 to 25 tested an automated diabetes reminder system in which a message was sent by cell phone text message or email reminding the patients to check and report their blood glucose level. If the patient did not respond within 15 minutes, another reminder message was sent. With an overall retention rate of 73 percent, more than a fourth of the participants never used the system, although the cell phone group was more likely than the email group to use it (82 percent versus 61 percent). Interestingly, two-thirds of those assigned to the email group commented that they would have preferred cell phone reminders. The authors concluded that the system was technically feasible and inexpensive to operate and that the increasing popularity of cell phones and text messaging may be ideal for targeting reminders to this population.

The authors of the seven systematic reviews consistently identified key limitations in study designs and methods: small sample sizes, lack of long-term outcomes, inability to isolate the effect of text messaging versus other program components, and inability to identify intervention features that contributed to successful outcomes (such as frequency, content, and duration of messages). A later section of this report discusses implications for future research.

Evidence from the Health Care Innovations Exchange

In a field that is evolving rapidly, the peer-reviewed literature may lag in publishing results on promising interventions. The Health Care Innovations Exchange was established by AHRQ to accelerate adoption of evidence-based programs for improving quality and reducing disparities. The AHRQ Innovations Exchange offers evidence from localized pilots on the effects of text messaging, either alone or in combination with other interventions. Table 6 summarizes evidence from 11 text messaging interventions profiled on the AHRQ Innovations Exchange website.²

Of the 11 interventions, 2 had strong evidence (though for 1 program, text messaging was just one of its many program components), 4 were moderate, and 5 were suggestive (see table for definitions). Nevertheless, the research suggests that most of the interventions had a positive effect on increasing patient awareness or knowledge related to health risks and behaviors; many may have led to improved access or utilization (such as increased clinic referrals or fewer missed appointments), and some improved adherence to recommended care (such as medication compliance, mood tracking, or diabetes management).

While the evidence of effectiveness in most of these studies is moderate or suggestive (rather than strong), the general findings are consistent with those in the systematic reviews of the potential for text messaging interventions to enhance traditional health care delivery. One caveat should be recognized, however. By definition, the evidence from the AHRQ Innovations Exchange is biased in favor of interventions that showed positive results. Thus, interventions that failed to observe positive results would be excluded.

² This review excludes interventions that were implemented in the United Kingdom or that involved text messaging between providers (such as to enhance specialty care referrals). The review is current as of December 6, 2013.

Table 6. Evidence of the Effectiveness of Health Text Messaging Programs Profiled on the AHRQ Health Care Innovations Exchange

Innovation Profile	Target Population	Intervention	Results
Evidence Rating: Strong			
Public Health Nurses Provide Case Management to Low-Income Women with Chronic Health Conditions, Leading to Improved Mental Health and Functional Status	Women in one urban and one rural county in north central Florida, randomly assigned to treatment or control groups	Nurses conducted health screenings, provided support and education by phone and in person, and made referrals to mental and physical health providers; in addition, nurses used text messaging as necessary to make sure health-related needs were met	<ul style="list-style-type: none"> Increased first-time mental health visits among those with depression or depressive symptoms Larger improvements in functional status Earlier transitions to employment <p>Note: Text messaging was one part of a larger intervention; the effectiveness of text messaging was not isolated</p>
Text Messages to Parents Increase Influenza Immunization Rate for Low-Income, Minority Children	Low-income, predominantly Hispanic parents of children ages 6 months to 18 years receiving pediatric services in the past year from four clinics associated with New York-Presbyterian/Columbia University Medical Center	The hospital sent five customized weekly text messages to parents educating them about the seriousness of influenza and the safety of the vaccine, and encouraging them to get their children vaccinated during the influenza season; the messages were available in English or Spanish and the start of the messages was staggered to avoid overwhelming the Saturday flu clinics; data from the hospital record and New York City immunization registry were linked to track receipt of the vaccine regardless of the location; parents also received an automated telephone reminder message	<ul style="list-style-type: none"> Small but meaningful increase in the influenza vaccination rate in the text-message group versus the control group Higher vaccination rate observed both early in the flu season (when vaccination is most effective) and sustained for six months after the program began
Evidence Rating: Moderate			
Daily Patient-Provider Communication and Data Transfer Using Mobile Phones Improves Outcomes and Reduces Costs for Teens with Chronic Asthma	Bilingual children and teens with severe persistent asthma cared for by physicians at three clinics associated with San Mateo Medical Center	Asthma patients received a mobile phone with disease management software and recorded answers to 20 symptom questions; an electronic diary recorded details about their condition; information was monitored by an asthma care coordinator, who provided automated or personalized feedback based on an algorithm; feedback included encouragement, suggested modifications to their daily plan, alerts, and reminders about tests, prescriptions, and appointments	<ul style="list-style-type: none"> Improved adherence to prescribed drug regimens Stronger adherence to electronic diary versus usual reporting through paper diary logs Emergency department and missed school days decreased

Table 6 (continued)

Innovation Profile	Target Population	Intervention	Results
Monthly Text Messages Increase Compliance with Recommended Blood Glucose Testing in Medicaid Managed Care Enrollees with Diabetes	Diabetic teens and adults enrolled in Delaware Physicians Care (Medicaid managed care plan)	Diabetic teens and adults enrolled in Delaware's Medicaid program recruited by disease managers to receive monthly educational messages along with reminders to get their HbA1c levels tested regularly; intensity of the outreach and recruitment effort varies according to diabetes severity	<ul style="list-style-type: none"> Increased compliance with recommended HbA1c testing guidelines among those participating in the program, compared to those not participating
Regular Reminders via Text Message Increase Adherence to Medication Regimen, Significantly Reduce Risk of Organ Rejection in Pediatric Liver Transplant	Children, adolescents, and young adults (aged 1 to 27) receiving liver transplants at Mount Sinai Hospital	Two-way text messaging reminding patients/caregivers about medications, with prompt to reply to confirm intake; follow-up message to caregiver if reply not received; if reply not received after two messages, provider alerted to contact patient/caregiver; physicians send motivational messages through text messages or by phone	<ul style="list-style-type: none"> Increased adherence to medication regimen, regardless of number of medications taken or who was responsible for medication intake Reduced number of patients at risk of a rejection episode Reduced number of rejection episodes
Low-Income Rural HIV/AIDS Patients Receive Regular Text Messages, Leading to Higher Quality of Life and Greater Engagement in Care	Patients with HIV/AIDS in the University of Virginia Health System who were disengaged or at risk of disengagement	Patients with HIV/AIDS who were disengaged from care (or at risk of disengagement) were identified through program records, and worked with providers to write their own messages about HIV/AIDS care (taking medications, keeping clinic appointments, refilling prescriptions); the typical patient received 14 reminders per week; patients were given a cell phone by the program with a limited number of outgoing calls	<ul style="list-style-type: none"> Greater retention in care for six months than comparison/control groups Improved health-related quality of life
Evidence Rating: Suggestive			
Texting Service Enhances Minority Youth Access to HIV/AIDS Information and Testing	Minority youth and young adults (aged 13 to 35) in Illinois	Multimedia public awareness campaign, peer educator program, text messaging program (called Text 2 Survive), and other outreach activities to connect minority youth to HIV testing and related services; text messaging services include list of free health events; educational tips roughly once a month; quizzes and contests; medication reminders; and appointment reminders	<ul style="list-style-type: none"> Enhanced access to HIV testing through use of text messaging service to locate testing sites (actual testing rates not tracked due to confidentiality) Enhanced access to health information via regular text messages

Table 6 (continued)

Innovation Profile	Target Population	Intervention	Results
Weekly Text Messaging Service Enhances Access to Local Clinics and Accurate Information on Sexual Health for Teens and Young Adults	Adolescents (aged 13 to 18) in California	Users sign up for the statewide service by texting 'Hookup' to 61827 and automatically receive tips on such topics as STDs, birth control, emergency contraception, sexual communication, domestic violence, and substance abuse; each text message includes a prompt that offers information on where to get testing and other services	<ul style="list-style-type: none"> Expanded access to health information among users Changes in behaviors (such as asking a partner about their sexual history) and knowledge (such as increased awareness that birth control pills do not protect against STDs) Frequent requests for clinic referrals, which suggests increased access to services
Mental Health Patients Track Moods Through Web Application, Generating Greater Adherence to Daily Tracking, Better Treatment Decisions, and High Satisfaction	Patients with depression or other mood disorders; developed by HealthCentral and Johns Hopkins University and available at mood247.com	An adjunct to face-to-face counseling, Mood 24/7 sends a daily text message reminding patients to assess and report their mood; patients can annotate the rating and share the secure, web-based personal mood chart with providers to inform their treatment decisions and observe treatment effects over time	<ul style="list-style-type: none"> Increased adherence to daily mood tracking compared to paper-based tools Better treatment decisions that are more timely and appropriate Higher clinician satisfaction with web-based system than traditional paper-based reporting system
Text Messaging Program Increases Awareness and Concern About Sexually Transmitted Diseases Among At-Risk Youth, Particularly African Americans	At-risk African American teens aged 13 to 18 in San Francisco	SexInfo provides free basic information and referrals via an "opt-in" text messaging program, with automated responses to specific situations (e.g., broken condom, partner cheating); also provides a companion website with sample messages	<ul style="list-style-type: none"> Increased access to information and referrals as reflected by the number of inquiries Higher awareness of program among target population (African American youth) than others Greater concern about STDs among those who had seen the campaign than those who did not

Table 6 (continued)

Innovation Profile	Target Population	Intervention	Results
Emergency Department (ED) - Based Case Managers Throughout County Electronically Schedule Clinic Appointments for Underserved Patients, Allowing Many to Establish a Medical Home	Medicaid and uninsured patients with a chronic condition, avoidable ED visit, and no medical home through the Milwaukee Health Care Partnership, including nine county EDs and four federally qualified health centers	Patients meet with a case manager in the ED about the importance of a medical home and schedule an appointment at a clinic or health center through an electronic application; case manager reminds patient about upcoming appointment by email, text message, or phone; case manager also follows up on missed appointments	<ul style="list-style-type: none"> • Increased number of patients receiving care at health centers and clinics, based on the number who scheduled and kept an initial appointment • Increased number of patients establishing a medical home at a health center, based on the number returning for a second visit within six months • Reduced number of ED visits among patients who kept their scheduled appointments

Source: AHRQ Health Care Innovations Exchange [<http://www.innovations.ahrq.gov/about.aspx>], Results of Search on “Text Messaging,” “Text Message,” “Social Media,” “SMS,” “Mobile Health,” and “mHealth.” Includes innovations implemented in the United States that had a health text messaging component.

Note: The evidence ratings are defined as follows: (1) strong evidence is based on experimental designs with results that showed consistent direct evidence of the effectiveness of the innovation in improving health outcomes and/or processes; (2) moderate evidence is based on a systematic evaluation of the innovation using a quasi-experimental design with results that showed consistent direct evidence of effectiveness, although the strength of the evidence is limited due to the size, quality, or generalizability of the evaluation; (3) suggestive evidence is based on non-experimental or qualitative evidence that supports an association between the innovation and health outcomes and/or processes. Innovations that do not meet the minimum inclusion criteria are excluded from the Innovation Profile.

Evidence on the Acceptance of Health Text Messaging Programs

As policymakers and clinicians consider the evidence on effectiveness of health text messaging programs based on clinical outcomes, they should also take into account evidence on the acceptance of such programs based on measures of utilization, satisfaction, and retention. As already noted, the clinical trials exhibited wide ranges of retention and acceptance, which may affect clinical effectiveness depending on the level of patient engagement in the program. Descriptive studies provide insights about patient preferences for receiving health information and reminders through text messages, as well as their retention in interventions once they are enrolled. They suggest the opportunities (and potential barriers) for spreading text messaging from controlled interventions into regular practice.

Findings suggest that the acceptance of text messaging may vary by target population and content area. For example, studies related to the use of text messaging to promote sexual health suggest that text messages are well accepted (Levine et al. 2008; Gold et al. 2010). One of the AHRQ Health Care Innovations, SEXINFO, was evaluated using focus groups and other qualitative methods to assess utilization and satisfaction with a text message information and referral service aimed at reducing rising rates of gonorrhea in San Francisco among those aged 15 to 19 (Levine et al. 2008). The authors found that awareness of the campaign was high, particularly among African American youths and those living in the target geographic areas. The number of inquiries for more information and referrals was higher than expected. Although this study was not of sufficient rigor to be included in a systematic review, Cole-Lewis and Kershaw (2010) noted that SEXINFO is among the text messaging interventions that “capitalize on the existing cultural behaviors of young populations, given their rates of access and use of mobile technology.”

Gold et al. (2010) conducted a pre-post study of changes in sexual health knowledge (including sexually transmitted infections [STIs] and condom use) among people aged 16 to 29 who had attended a music festival in Australia. Twelve messages were sent over a four-month period. Most of the participants found the text messages entertaining (80 percent) and informative (68 percent), and shared messages with others (73 percent). In addition, participants preferred messages that used informal language, rhymed, were funny, and tied into specific events (such as Valentine’s Day). Participants desired a balance between new information and reminders (such as for STI testing). Knowledge increased significantly among both males and females. Another Australian study randomized participants to an intervention group that received both text messages and email messages about sexual health topics and a control group that received no messages (Lim et al. 2012). While the intervention had a positive impact on health knowledge, the authors found that participants in the intervention tended to have more favorable reactions to the text messages than the email messages. Participants were more likely to recall the text messages, to share the text messages with friends, and to find the text messages interesting or entertaining, but also more likely to consider the text messages annoying. (The study, however, did not isolate the individual versus the joint effects of the text messages and email messages.) Overall, recent research on the use of text messages related to sexual health suggests that text messaging offers promise for reaching teens about health information, referrals, and testing reminders (Gard and Furberg 2012).

A proof-of-concept study of a text message intervention for HIV-positive men demonstrated strong receptivity to messages designed to increase HIV knowledge, reduce risky behaviors, provide social support, and promote patient involvement (Uhrig et al. 2012). Both tailored and non-tailored messages were included. Tailored messages targeted a person’s sex and substance use risk behaviors (sent on Saturday evenings) or offered specific social supports (support groups, meetings, events) based on an individual’s demographics or risk status. Non-tailored messages addressed healthy living topics (sent on

Wednesdays), the general availability of social supports (sent on Sundays), and participant involvement in their health care (sent on Mondays). The study provided extensive evidence of participants' receptivity to the messages, with 98 percent saying the messages were easy to understand, 89 percent saying they trusted the information, and 86 percent saying they always read the messages. Fewer said they learned something new from the messages (61 percent) or that the messages motivated them to change their behavior (44 percent). Although the study found increases in health knowledge and reduction in risky behavior, the lack of a control group precludes drawing conclusions about the impact of the program on these outcomes. Other studies have also shown the potential of mobile phone-based HIV-prevention behavioral interventions, based on behavioral theory and design considerations, but evidence of their effectiveness remains scant (Winchester 2009).

These studies suggest high levels of acceptance of health text messaging interventions among teens and young adults. In contrast, evidence about acceptance of text messaging for immunization reminders among parents is more mixed. For example, a national study of parent preferences found that most parents preferred to receive their children's immunization reminders via traditional communication modes of mail (33 percent) or a call to their home telephone (35 percent) (Clark et al. 2011). Another 16 percent preferred email. The study found that more than half of parents would be willing to give their cell phone number to their children's immunization provider, though only 8 percent preferred calls to their cell phone, and 3 percent preferred a text message. The remaining 5 percent did not want any reminder notice.

The response to text message immunization reminders was more positive in focus groups and interactive exercises conducted in English and Spanish with pregnant women and parents of adolescents in New York City (Kharbanda et al. 2011; Kharbanda et al. 2009). One study found that parents of adolescents were uniformly interested in text message immunization reminders and suggested the messages be simple, short, and personalized (Kharbanda et al. 2009). Many said they would prefer text messages to phone or email reminders. In the interactive exercise, most demonstrated that they could retrieve the sample text messages as well as read and understand their content. However, because most of the participants had limited experience with text messaging at the time of the study, many were not able to reply. Pregnant women also expressed interest in receiving informational and reminder text messages about influenza vaccines during pregnancy, and even those who had refused the vaccine thought the messages would encourage women to talk to clinicians about the vaccine during their prenatal visits (Kharbanda et al. 2011). Related studies that empirically tested the impact of text messaging immunization reminders found that influenza vaccination rates were significantly higher in the intervention group (43.6 percent) than in the usual-care group (39.9 percent) (Stockwell 2012a).³ In an accompanying editorial, Szilagyi and Adams (2012) estimated that if similar effects were observed nationally, an additional 2.5 million children and adolescents would have received influenza vaccination. Stockwell et al. (2012b) also found that immunization rates were significantly higher in two studies that used text messages to improve routine immunization coverage among children and adolescents.

³ An innovation of this study was the linkage between the clinics' immunization information system (which collects data automatically from electronic health records) and the citywide immunization registry to obtain information about vaccines administered by other providers.

Implications for Improving Future Research and Program Implementation

This report has presented evidence demonstrating the promise of health text messaging programs to improve health behaviors and outcomes, particularly related to smoking cessation and diabetes management. Studies have suggested that text messaging programs targeted to youth and young adults can provide health information on sexual health and HIV/AIDS, although the quality of the evidence is often rated as moderate rather than strong. Many observers have noted that the lack of strong evidence limits the scaling and sustainability of interventions (Adler 2007; Vital Wave Consulting 2009; Mechael et al. 2010).⁴ Furthermore, Nilsen et al. (2012) commented that “the development of mHealth technologies is currently progressing at a much faster pace than the science to evaluate their validity and efficacy, introducing the risk that ineffective or even potentially harmful or iatrogenic applications will be implemented.”

Therefore, the building of a strong evidence base for the effectiveness and acceptance of text messaging and other mHealth interventions requires additional research, with particular attention to enhancing the quality of the evidence. The suggestions focus on three areas for enhancement: (1) general study design, (2) study planning, and (3) study analytics. In addition, three strategies for ongoing monitoring of program implementation and effectiveness are suggested.

General Study Design

- **Strengthen Methodological Rigor.** The methodologies used by existing studies do not all provide strong evidence of effectiveness. Studies that include RCTs or quasi-experimental designs with comparison groups produce the strongest evidence, while those using pre-post designs without a comparison group, or using other non-experimental designs, produce weaker evidence (and, at best, may be suggestive only of an association). Because experimental designs may be difficult to implement as a result of the widespread availability of text messaging programs and other mHealth technologies, natural experiments should also be explored, for example, varying the features of the intervention (such as message content) or aspects of participation (such as dosage) (Evans et al. 2012). In general, studies should choose the design most appropriate to the developmental stage of the research (Nilsen et al. 2012).
- **Increase Sample Sizes.** Sample sizes were often too small (typically from 5 to 200 people) to generate statistically significant results. Future studies should conduct formal power calculations and ensure that sample sizes provide sufficient power to detect significant results.
- **Lengthen Duration of Follow-up.** Many studies included short-term outcomes (such as behavior change during the intervention) and did not address longer-term outcomes (such as smoking cessation 6 to 12 months post-intervention). To demonstrate the value of text messaging interventions, studies should include longer-term outcomes where feasible.

⁴ The World Health Organization (2011) found that despite the growing level of global mHealth activity, only 12 percent of countries reported evaluating their mHealth activities. The WHO study highlighted the importance of evaluation for determining cost-effectiveness, educating the public about the benefits of mHealth, and supporting evidence-based government policy decisions.

Study Planning

- **Incorporate Theory of Change and Formative Evaluation Methods into Study Designs.** Whittaker and colleagues (2012b) recommend that planning, implementation, and evaluation of future interventions follow a systematic, intentional process that begins with conceptualization (incorporating theory and evidence) and formative research (incorporating input from the target audience), and follows with pretesting and a pilot study of the intervention content and procedures. The authors then recommend the implementation of RCTs to develop rigorous evidence of program effects, and finally qualitative follow-up to learn how participants used the intervention. While they note that this process can be time-consuming, they highlight the importance of relying on theory and evidence in designing the intervention as well as the process of engaging the target audience in formative and qualitative follow-up.
- **Use Standardized Outcome Measures.** The use of common outcome measures across studies would facilitate comparisons of results related to intervention effectiveness. Future efforts to standardize measures of health knowledge, behaviors, and clinical outcomes should include both self-reported and administrative data sources (including electronic health records). With the proliferation of small pilot and feasibility studies, generalizability is limited; however, more standardized measures and methods would support meta-analyses and systematic reviews.

Study Analytics

- **Isolate the Effects of Specific Intervention Design Features.** Future studies should aim to understand the contributions of specific design features—such as number, content, frequency, tailoring, duration, and interactivity of text messages—on health knowledge, behavior change, and clinical outcomes. While experiments provide the most rigorous evidence, natural experiments, meta-analyses, and descriptive studies can be used to shed light on the effects of program design (or changes in design). In addition to examining health-related measures, future studies should examine variations in initial participation and retention rates across interventions.
- **Assess the Comparative Effectiveness of Different Treatment Modalities.** Further evidence should be developed on the effectiveness of text messaging interventions (such as appointment reminders, drug adherence, and disease management) relative to email, other web-based approaches, and usual care. Similarly, future research should assess the effectiveness of stand-alone text messaging interventions versus those that are integrated with other technology components (such as monitoring of medications or tracking of vital signs) or health supports (such as phone calls or in-person visits). Such information would facilitate adoption of more-effective, and discontinuation of less-effective, practices. In addition to assessing effects on patients, studies should assess effects on providers, such as their perceptions of practice efficiencies, burden, and care quality.
- **Conduct Cost-Benefit Analyses.** Little is known about the effect of text messaging and other mHealth technologies on health care costs. Schweitzer and Synowiec (2012) suggest that although unit costs for certain services might decrease as a result of increased efficiency (such as fewer missed appointments), overall costs may increase as utilization increases. Moreover, benefits might increase through improved access to high quality care (such as timely referrals to services, medication reminders, and chronic disease management). Future studies should examine the systemwide costs and benefits,

including potential operating efficiencies that could result in labor cost savings as well as quality and access improvements. Such information will contribute to an assessment of the business case for broader investment and third-party reimbursement, and provide information on how to achieve scaling and sustainability.

- **Examine Differential Effects on Subpopulations.** To understand the potential of text messaging interventions to address disparities, future research should disaggregate results for selected subpopulations, such as racial/ethnic minorities, low-literacy populations, and people with disabilities. Specific attention should be given to the appropriateness of the message content for diverse populations in relation to cultural competence and health literacy levels (Tirado 2011). Adequate sample sizes will be required to enable subpopulation analyses. In addition, choice of research settings may be affected to ensure sufficient samples in smaller subgroups.
- **Ensure That Study Conclusions Are Supported by the Study Design.** In general, inferences about the impact of an intervention can be made only when there is an appropriate control or comparison group to rule out other factors that could influence study results. Researchers should be careful not to infer impacts of interventions using data that are not designed for such inferences. For example, descriptive studies based on a pre-post or cross-sectional design without an appropriate comparison group are not sufficiently rigorous to attribute changes in knowledge or behavior to an intervention.

Ongoing Monitoring Strategies

- **Conduct an Ongoing Environmental Scan of Health Text Messaging Programs in the United States.** There can be no doubt that the pace of implementation is accelerating, as illustrated by the implementation of the txt4health™ mobile diabetes intervention in three Beacon Communities (Cincinnati, Detroit, and New Orleans). Systematic tracking of new initiatives and their evaluation plans would be desirable to facilitate future assessments of program implementation and effects of text4health initiatives, as well as to promote sharing of lessons learned.
- **Conduct Periodic Systematic Reviews of Evidence on High-Priority Topics.** With the proliferation of recent research, accompanied by the varying quality of existing research evidence, more emphasis should be placed on conducting systematic reviews of the research. The reviews should address high-priority topics that can help improve program design and implementation, such as impacts of specific design features and differential impacts on subpopulations.
- **Determine the Reach of Health Text Messaging Programs.** Although clinical trials are essential for developing a rigorous evidence base about program impacts (such as knowledge, behaviors, and clinical outcomes), they provide limited insight about use of text messaging interventions in a population context or a “real-life” practice environment. Although research suggests that these programs have basic appeal, particularly to young adults, many studies have experienced challenges in enrolling, engaging, and retaining participants (Preston et al. 2011; Hanauer et al. 2009; Haug et al. 2009). Future research should include quantitative measures of participation and qualitative assessments of reasons for not enrolling or for disenrolling (including both financial and non-financial barriers).

Concluding Remarks

With the near-ubiquitous presence of cell phones and the rapid growth of smart phones, text messaging and other mHealth interventions can remove traditional geographic and economic barriers to access to health information and services. The higher rates of mobile phone ownership and use among Blacks and Hispanics, compared to Whites, are particularly noteworthy. These interventions have the potential to improve health knowledge, behaviors, and outcomes and, ultimately, to reduce disparities.

A substantial body of research has shown that text messaging programs can bring about behavior change to improve short-term smoking cessation outcomes as well as short-term diabetes management and clinical outcomes (such as increased frequency of blood glucose monitoring and decreased HbA1c levels). Research has shown that text messaging improves treatment compliance, including both medication adherence and appointment attendance. Research also suggests that text messaging can improve immunization rates, increase sexual health knowledge, and reduce risky behaviors related to HIV transmission, although the literature is less definitive in these areas. The literature is expanding rapidly and new studies will continue to contribute to the evidence base on the effectiveness and acceptance of health text messaging (see Free et al. 2013 for a recent example).

The recent proliferation of health text messaging applications in the United States is consistent with the recommendations of the HHS Text4Health Task Force.⁵ This environmental scan has identified various strategies for addressing gaps in knowledge about the effectiveness and acceptance of health text messaging programs. Future efforts should include (1) conducting an ongoing environmental scan of the field, (2) performing systematic reviews of new research and sharing lessons learned, and (3) determining the reach of text messaging programs, particularly among underserved populations. In addition, future research should focus on assessing long-term outcomes of text messaging interventions.

The trends toward wide spread ownership of cell phones and widespread text message use across virtually all segments of the U.S. population will continue to support the spread of health text messaging programs. This scan provides encouraging evidence related to the use of health text messaging to improve health promotion, disease prevention, and disease management.

⁵ The task force recommendations are available at <http://www.hhs.gov/open/initiatives/mhealth/recommendations.html>.

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Text4baby National Evaluation Technical Advisory Group (TAG)

In September 2010, following consultation with the Text4baby National Evaluation Technical Advisory Group (TAG), the Health Resources and Services Administration (HRSA) awarded a contract to conduct an evaluation of the Text4baby program. The ongoing commitment, engagement, and contribution of the TAG have been critical to the success of this effort. The TAG is composed of representatives from several U.S. Department of Health and Human Services agencies, the U.S. Department of Agriculture, and the White House Office of Science and Technology Policy. Throughout the course of the evaluation, the TAG has provided invaluable guidance on the development of the key evaluation questions, methodology, implementation, analysis, and summary report of findings.

Participating Organizations

U.S. Department of Agriculture

U.S. Department of Health and Human Services Agencies

Administration for Children and Families

Agency for Healthcare Research and Quality

Centers for Disease Control and Prevention (TAG co-chair)

Centers for Medicare & Medicaid Services

Health Resources and Services Administration (TAG co-chair)

Indian Health Service

National Institutes of Health

Office of Adolescent Health (HHS)

Office of the Assistant Secretary for Planning and Evaluation (HHS)

Office on Women's Health (HHS)

Substance Abuse and Mental Health Services Administration

White House Office of Science and Technology Policy
