



Using text message reminders in health care services: A narrative literature review



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ABSTRACT

Introduction: Despite the extensive use of mHealth behavior change interventions, questions remain about the use of technology-based reminders in delivering health care services. Text messaging, or short message service (SMS), is one reminder method that has been extensively researched. Most SMS-reminder research is distributed across a range of health care outcomes. The aim of this article is to systematically review the aggregate impact of these reminders on overall health care outcomes.

Methods: A systematic literature review was conducted and yielded 2316 articles. Studies were included if they used SMS reminders to support patient health care outcomes. Study methodology was aligned with the PRISMA guidelines for systematic reviews.

Results: Following screening, 162 articles met inclusion criteria. Of these studies, 93 investigated medical compliance reminders and 56 investigated appointment reminders. The review found that nearly all the SMS-reminder studies helped improve patient medical compliance and appointment reminders. Additionally, researchers reported numerous benefits from using SMS reminders, including ease of use, relative inexpensiveness, and rapid and automated message delivery. Minimal risks were reported and most participants found the reminders to be acceptable.

Discussion: Text messages appear to be an effective reminder mechanism to promote improved patient appointment and medical compliance. Reminders should continue to be evaluated and improved to determine the most effective timing and frequency of messages for improving outcomes.

1. Introduction

In 2017, there were an estimated 7.7 billion mobile phones used, approximately one phone per person on the planet (International Telecommunication Union, 2017). Mobile phones, and more recently smartphones, have quickly changed the way people communicate and the way treatment providers think about service delivery (Atun and Sittampalam, 2006). Mobile phones are used in a variety of settings for various purposes, including in impoverished countries where mobile phones offer a relatively inexpensive method of communication (Ben-Zeev et al., 2015; Free et al., 2010); for treating individuals with psychological problems (Thomas et al., 2017); and for routine communication among individuals of all ages (Center for Substance Abuse Treatment, 2009; Global Attitudes Project, 2012). Due to the ubiquity of text messaging (short message service, SMS) (Gatwood et al., 2016), customizability (e.g., Downer et al., 2005), relative low cost (e.g.,

Rohman et al., 2015), rapid and automated delivery (e.g., Chung et al., 2015), and acceptability (Garofalo et al., 2016), SMS has become a focus of researchers in the health care field and is recommended for use by leading organizations in various health care fields (e.g., American Medical Association, 2016; World Health Organization, 2012). Nevertheless, SMS is a relatively nascent technology. Using it in research requires continuous researcher education on ever-changing SMS treatment guidelines and implementation methods, and frequent training of research staff that help implement the rapidly evolving interventions.

Research on SMS in health care services has been focused on two main areas: behavior change interventions and reminders. Mobile Health (mHealth) is defined as the use of mobile computing and communication technologies in health care and public health (Berrouiguet et al., 2016; Free et al., 2010). Behavior change interventions and reminders both fall under the umbrella of mHealth. Although mHealth reminder research has primarily focused on outcomes such as

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appointment attendance and medication adherence (Berrouiguet et al., 2016; Kannisto et al., 2014), SMS reminders can also play an important role in behavior change. As proposed in the transtheoretical model of change, reminders can serve as coaching or prompts to help facilitate behavior change (Prochaska et al., 1994). They are likened to stop signs at a busy intersection—reminding us how to respond next. Reminders can be used to enhance prospective memory, which is remembering to complete an activity in the future (Guynn et al., 1998; McDaniel et al., 2004).

Before the cell phone era, Prochaska et al. (1994) highlighted the utility of alarm clocks, calendars, and timers as tools for delivering personal reminders. These tools are now easily and frequently accessed from one source: the mobile phone (Madden et al., 2013; Nelson and Nelson, 2010). Mobile phones can receive automated SMS reminders or notifications that remind the user to do (or not to do) a specific behavior. For example, if an individual is attempting to decrease their substance use, they can receive an automated SMS that reminds them of their goal at certain high-risk times; and if an individual is attempting to lose weight, they can receive a reminder not to snack between meals. Recently, some research has begun to investigate the impact of adjunct reminders (i.e., mHealth reminders as an adjunct to a behavior change intervention) (e.g., Aguilera et al., 2017). Due to the paucity of research on adjunct reminders at this time, they will not be included as part of the systematic review. However, this topic is covered in the Discussion section. The current review will address the following questions about the use of mHealth reminders in health care: What specific uses mHealth reminders been applied to in health care? How has the impact of mHealth reminders been assessed? What have we learned about designing reminders for health care? The review methodology has been aligned with the PRISMA guidelines for systematic reviews (Moher et al., 2009).

2. Method

2.1. Objective

The objective of this study is to provide a systematic narrative review of the application of SMS reminders in health care services. All studies were categorized using a two-step process. First, all the titles and abstracts were reviewed for relevance to the topic and to see if they met inclusion criteria. Second, the studies were read and categorized by methodology, treatment goal, and target health condition.

2.2. Search strategy

An extensive literature search was conducted in April 2018 using the PsychINFO, CINAHL, PubMed, and Web of Science electronic databases. The search terms used were selected to broadly examine the impact of text message reminders on health care outcomes (see Fig. 1). Titles, abstracts, and reference lists of the selected studies were also reviewed to check for other potentially relevant studies.

2.3. Selection criteria

The review was limited to peer-reviewed articles published in English between 2003 and 2018, with an abstract available online. The starting date of the search was selected for three reasons: (1) the majority of mHealth research has occurred after 2003, (2) the rate of text messaging and cell phone ownership has greatly increased since 2003 (International Telecommunication Union, 2017; Kannisto et al., 2014), and (3) 2003 is a typical beginning date for mHealth literature reviews (Berrouiguet et al., 2016; Kannisto et al., 2014). The review was limited to studies of SMS reminders used to support patient health care. While the majority of studies sent SMS directly to the patients, some health care needs necessitate the reminders be sent to guardians or caretakers rather than the patient. There was no limitation on patient population,

age, or diagnosis. Excluded from this review were: articles that assessed patients' feelings toward SMS for non-clinical purposes (e.g., to create a list of SMS messages or assess expected acceptability of receiving messages), theoretical papers, statistical reviews, dissertations, editorials, letters, and study protocols. Both randomized control trials (RCTs) and non-RCTs (e.g., feasibility studies, before-and-after studies, cross-sectional studies, cohort studies) were included.

3. Results

3.1. Study selection

The steps illustrating the literature search and article review process are shown in Fig. 1. The initial search produced 2316 articles. An additional 62 articles were found by looking at the reference list of each article. After checking for duplicates as well as screening titles and abstracts for relevance to the topic, 196 potential full-text articles were obtained, with 162 articles ultimately meeting inclusion criteria after full-text review.

3.2. Characteristics of studies reviewed

Author, year, country, research setting, type of study, patient group, sample size, and message dose (i.e., timing of messages, frequency of messages, total number of messages) were extracted to describe the characteristics of the study. These results have been summarized in Table 1. The number of articles published on this topic has gradually increased over time, peaking in 2015 (35/162; 22%). Approximately one-third of the studies reviewed were conducted in the United States (60/162; 37%).

Nearly two-thirds (111/162; 68%) of the studies reviewed were randomized control trials (RCTs), with a marked increase in RCTs after 2013. Non-RCTs were recorded as quasi-experimental. Additional descriptive characteristics of the studies are presented in more detail in Table 1.

3.3. Purposes of text message reminders in health care treatment

The reported purpose of the study, description of the intervention, and dose of the intervention were extracted to describe the most commonly studied application of mHealth reminders in health care. SMS reminders were primarily used to remind patients to comply with a medical practice (e.g., taking medication on time, following non-medical treatment guidelines, and completing vaccinations) (93/162; 57%) or attend a clinical appointment (56/162; 35%). Reminders for appointment attendance were generally used as a method to increase clinical appointment attendance and the rate of advance cancellations (as opposed to not showing up). Various studies assessed the impact of SMS reminders on decreasing the rate of missed appointments across a variety of settings, including first-time psychotherapy appointments (Clough and Casey, 2014), recurring medical appointments (Branson et al., 2013; Tolonen et al., 2014), and completing vaccinations (Stockwell et al., 2014).

In a majority of studies (140/162; 86%), SMS reminders were the only intervention used. The remaining studies used a secondary or complimentary component in conjunction with the SMS reminder. These include educational or informational messages about the treatment target (e.g., Stockwell et al., 2014), links to additional educational information (e.g., Kodama et al., 2016), phone call reminders and/or mailed reminders (e.g., Baker et al., 2015), and motivational or supportive messages (e.g., Celik et al., 2015).

3.4. Message dosage and timing

Across the studies, it was most common that the dose (number) and timing of messages were individually customized based on the patients'

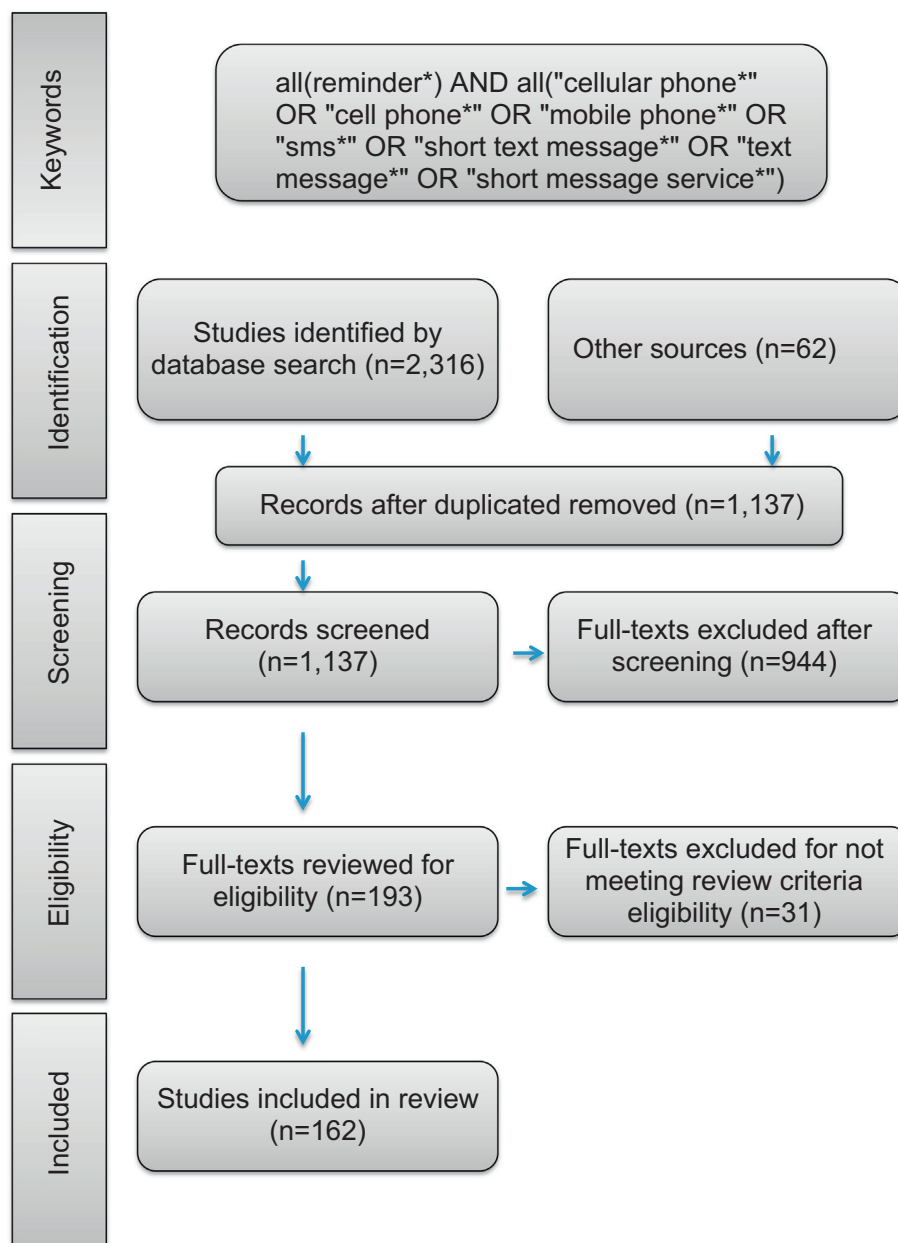


Fig. 1. PRISMA flowchart of primary study selection.

medication or treatment schedule, or scheduled appointments. Other studies used researcher-selected dosing (Belton et al., 2013; Odeny et al., 2014). Many studies sent daily or weekly messages, however, not all studies reported details about message timing. Some studies set message dosage based solely on patient preference (e.g., Spohr et al., 2015), and others reported the total amount of reminders sent rather than when they were sent (e.g., Celik et al., 2015).

Specific timing of reminders varied across studies. Detailed timing (e.g., a specific time or time frame) was reported in 75 of 162 (46%) of the studies reviewed. Medication reminders typically were sent near the scheduled medication time (e.g., Mao et al., 2008). Specific appointment reminder time was reported in 86% (49/57) of studies. These reminders occurred between two weeks (Kunigiri et al., 2014) and the morning of (Prasad and Anand, 2012) a scheduled appointment. Additionally, studies reminding individuals to complete a medical follow-up exam sent a reminder message up to six months after initial contact (Van Ryswyk et al., 2015).

3.5. Appointment reminders

Of the studies reviewed, 56 of 162 (35%) used SMS appointment reminders. Some of these studies targeted increased appointment attendance (Thomas et al., 2017), while others targeted decreased missed appointments (Altuwajiri et al., 2012) or increased cancellations ahead of time (rather than not showing up) (Farmer et al., 2014). The study of appointment reminders has occurred in a variety of settings, including primary care (Steiner et al., 2016), dental care (Perry, 2011), and psychotherapy clinics (Delgadillo et al., 2015). Appointment attendance reminders were found to either increase the rate of appointment attendance, increase the rate of appointments cancelled ahead of time, or decrease the rate of missed appointments in 48 of the 56 studies (86%) (Altuwajiri et al., 2012; Arora et al., 2015; Berenson et al., 2016; Bourne et al., 2011; Brannan et al., 2011; Branson et al., 2013; Chen et al., 2008; da Costa et al., 2010; Deng et al., 2015; Downer et al., 2005; Fairhurst and Sheikh, 2008; Farmer et al., 2014; Foley and O'Neill, 2009; Geraghty et al., 2008; Hofstetter et al., 2015a, 2015b;

Table 1
Basic study information with review of messaging details and outcomes.

Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Abroms et al. (2014)	503	RCT	Interactive, personalized, automated text messages designed to help support smoking cessation among adults in the United States	Smoking cessation	Individually customized for six months; maximum of five per day	Individually customized	Intervention produced statistically significant improvement in smoking abstinence
Akhu-Zaheya and Shiyab (2017)	160	RCT	Automated text message reminders designed to increase medication adherence for adult patients with cardiovascular disease in Jordan	Medication adherence	Three reminders per day (one each of medication reminder, diet reminder, smoking cessation reminder) for three months	Individually customized	Intervention produced statistically significant improvement in medication and healthy diet adherence. No significant difference on intention to quit smoking.
Altuwajiri et al. (2012)	Total not reported	Quasi-experimental	Automated text message reminder designed to increase appointment attendance among outpatient adults in Saudi Arabia	Appointment reminder	Two messages per scheduled appointment	Delivered five days and one day before scheduled appointment	Intervention produced statistically significant increase in appointment attendance rate
Anthony et al. (2015)	123	RCT	Automated, two-way messaging designed to increase frequency of blood pressure measurement among outpatients at a clinic in the United States	Medical treatment adherence	Two messages per day for up to 15 days	Morning and evening	Intervention produced statistically significant improvement in blood pressure measurement rate
Armstrong et al. (2009)	70	RCT	Automated text message reminder designed to increase sunscreen application among young adults in the United States	Treatment adherence	One message per day for six weeks	Between 6:30 and 7:00 AM	Intervention produced statistically significant increase in sunscreen application adherence
Arora et al. (2012)	23	Quasi-experimental	Automatic text message reminders in five categories (1. Educational and motivational 2. Medication reminders 3. Healthy living challenges 4. Trivia 5. Phone links) designed for adults taking medication for diabetes management in the United States	Medication adherence	Three messages per day for three weeks	At 9:00 AM, 12:00 PM, and 6:00 PM	Intervention produced increase in medication adherence and diabetes self-efficacy
Arora et al. (2015)	324	RCT	Automated text messages designed to increase attendance at scheduled post-ED discharge outpatient visits among patients in the United States	Appointment reminder	Three messages per scheduled appointment	7, 3, and 1 day before schedule appointment	Intervention produced statistically significant improvement in appointment attendance
Baker et al. (2015)	185	Quasi-experimental	Multi-component reminders to complete colorectal cancer screening including automated text messages, mailed letters, and phone calls among a high cancer risk population in the United States	Screening reminder	One message sent two days after testing kit was mailed, and one message after two weeks if kit was not returned	Schedule coincided with send date of mailed testing kit	Intervention produced improvement in screening completion rate
Balato et al. (2013)	40	RCT	Automated text message reminders and educational messages designed to improve disease severity and quality of life measures among adult outpatients (ages 18–65) treated for psoriasis at an outpatient dermatology clinic in Italy	Medication reminder and educational messages	1 message per day for 12 weeks (3 reminders and 4 educational per week)	Not reported	Intervention produced statistically significant improvement in disease severity, quality of life, and adherence to therapy
Bangure et al. (2015)	304	RCT	Automated health information and reminder text messages designed to increase immunization rates of newborn children in Zimbabwe	Vaccine reminder	Three messages	6, 10, and 14 weeks after child birth	Intervention produced statistically significant improvement in vaccination completion rate
Bellucci et al. (2017)	862,745 ^a	Quasi-experimental	Personalized text message reminders designed to decrease failure to attend rate at an outpatient dental clinic at a dental hospital in Australia	Appointment reminder	One reminder message per scheduled appointment	One day before scheduled appointment	No significant difference in failure to attend rate
Belton et al. (2013)	65	RCT	Automated text message reminder designed to increase usage rate of accelerometer among adolescents in rural Ireland	Usage reminder	One message per day for 4 weeks	Before 8:00 AM on weekdays and before 9:30 AM on weekends	Intervention produced statistically significant increase in accelerometer use
Berenson et al. (2016)	877	Quasi-experimental	Automated text message reminders designed to increase	Appointment reminder			Intervention produced increased rate of

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Table 1 (continued)

Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
			appointment attendance among low-income post-partum women (14–26 years old) in the United States		Three reminders per scheduled appointment	4 days, 1 day, and 2 h before scheduled appointment	appointment attendance
Boker et al. (2012)	33	RCT	Automated text message reminder designed to increase adherence to acne medication regimen among patients in the United States	Medication adherence	Two messages per day for 12 weeks	One in the morning and one in the evening	Intervention did not produce increase in medication adherence
Bos et al. (2005)	301	RCT	Reminder either by mail, call, or automated text message designed to decrease rate of missed appointments among orthodontic patients in the Netherlands	Appointment reminder	One message per scheduled appointment	One day before scheduled appointment	Intervention did not produce change in appointment attendance
Bourne et al. (2011)	3551 ^a	Quasi-experimental	Automated text message reminder designed to increase HIV re-testing rate among men who have sex with men in Australia	Appointment reminder	One message per scheduled appointment	Not described	Intervention produced statistically significant increase in re-testing rate
Bowen et al. (2015)	50	RCT	Automated reminder and encouraging text messages designed to decrease amount of plaque on teeth	Tooth brushing reminder	12 messages during first 4 weeks, 1 message per week for following 8 weeks	Individually customized	Intervention produced statistically significant decrease in plaque amount on teeth
Brannan et al. (2011)	201 ^a	Quasi-experimental	Customized text message reminder designed to decrease ophthalmology clinic missed appointment rate in the United Kingdom	Appointment reminder	One message per scheduled appointment	Two weeks before scheduled appointment	Intervention produced a decrease in missed appointment rate
Branson et al. (2013)	48	Quasi-experimental	Manually-entered text message reminders designed to increase outpatient psychotherapy appointment adherence among adolescents in the United States	Appointment reminder	One message per scheduled session for 3 months (47/48 participants received 1 message per week)	The night before scheduled appointment	Intervention produced statistically significant increase in appointment attendance rate
Buis et al. (2017)	110	RCT	Automated text message reminders designed to promote hypertension medication adherence and educational messages with hypertension management recommendations for African-Americans in the United States	Medication adherence	Two medication reminders per day and two weekly educational messages both for one month	Individually customized	Intervention produced consistently higher numerically, but not statistically significant, medication adherence
Burton et al. (2014)	539	Quasi-experimental	Automated text message reminder designed to increase STI re-testing rates among adult patients at high risk for STI in the United Kingdom	Medical treatment adherence	One message	Individually customized (between 2 and 12 weeks after initial testing)	Intervention did not significantly improve STI re-testing rate
Celik et al. (2015)	221	Quasi-experimental	Automated text message reminders designed to increase knowledge about diabetes and insulin injections among patients with diabetes mellitus in Turkey	Informational reminders	12 messages sent twice a week for 6 months	Not specified	Intervention produced statistically significant improvement in injection technique and diabetes knowledge
Chen et al. (2008)	1848	RCT	Automated phone call or text message reminder designed to increase appointment attendance rate at a health promotion center in China	Appointment reminder	One message per scheduled appointment	Three days before scheduled appointment	Intervention produced statistically significant increase in appointment attendance rate
Chen et al. (2016)	11	Quasi-experimental	Automated text message reminders designed to increase Baduanjin exercise adherence among patients with severe mental illness in Taiwan	Exercise reminder	Two messages per week for eight weeks	Randomly selected	Intervention produced increased exercise rate on days receiving text messages
Chen et al. (2017)	66	RCT	Automated text message reminders designed to exercise compliance for adults with “frozen shoulders” treated at an outpatient clinic in Northern Taiwan	Exercise reminders	One message per day for two weeks	Either at 8 PM or individually customized	Intervention produced statistically significant improvement in exercise compliance and shoulder forward flexion/external rotation/internal rotation
Chow et al. (2015)	710	RCT	Tailored, automated text message advice, motivational reminders, and support designed to decrease LDL cholesterol among adult	Behavior change	Four messages per week for six months	Randomly selected time and date	Intervention produced statistically significant decrease in LDL

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Table 1 (continued)

Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Chung et al. (2015)	202	RCT	patients with coronary heart disease receiving treatment at a hospital in Australia Automated text message reminders and informational messages for completing a monthly breast cancer self-evaluation among patients that underwent surgery for breast cancer in Korea	Self-monitoring reminder	One reminder and one informational message per month for six months	The 1st (reminder) and 15th (informational) of each month	cholesterol, BMI, and systolic blood pressure Intervention produced statistically significant increase in breast self-evaluation
Clough and Casey (2014)	139	RCT	Automated text message reminder designed to increase intake appointment attendance at an outpatient training clinic in Australia	Appointment reminder	One message per appointment	Between 8:30 and 9:00 AM	Intervention did not significantly improve appointment attendance
Cocosila et al. (2009)	102	RCT	Automated text message reminders designed to increase medication adherence among adults with cell phones in Canada	Medication adherence	One message daily for first two weeks; One message every other days for final two weeks	Not reported	Intervention produced increase in medication adherence
da Costa et al. (2010)	32,709 ^a	Quasi-experimental	Automated text message reminder designed to decrease missed appointment rate at outpatient clinics in Brazil	Appointment reminder	One message per scheduled appointment	One day before scheduled appointment	Intervention produced statistically significant decrease in missed appointment rate
da Costa et al. (2012)	21	RCT	Automated text message reminder designed to increase ART medication adherence among HIV-positive Brazilian women	Medication adherence	One message per day on Saturday and Sunday and one message every other day during the week for 4 months	Sent 30 min before final scheduled daily medication dose	Intervention produced increase in medication adherence
Davey et al. (2016)	830	RCT	Automated text message reminders designed to increase retention in treatment among HIV-positive patients in Mozambique	Treatment adherence	Individually customized for 12 months	Individually customized	Intervention produced increase rate of treatment retention
Delgado et al. (2015)	254	RCT	A leaflet reminder or leaflet + automated text message reminders before initial psychotherapy session among primary care mental health service patients in England	Appointment reminder	One message	48 hours before first appointment	Intervention did not produce a change in appointment attendance rate
Deng et al. (2015)	1786	RCT	Automated text message reminder designed to decrease appointment cancellation rate for adult outpatients (ages 18–60) with a scheduled endoscopic surgery in Western China	Appointment reminder	Nine messages between scheduling and appointment date	Individually customized	Intervention produced a statistically significant decrease in appointment cancellation rate
Dick et al. (2011)	18	Quasi-experimental	Automated text message reminder designed to increase treatment adherence for adults with diabetes in the United States	Treatment adherence	One message per day for four weeks and one weekly treatment reminder	Not described	Intervention produced statistically significant increase in treatment adherence and in treatment self-efficacy
Downer et al. (2005)	2,864 ^b	Quasi-experimental	Automated text message reminder designed to decrease rate of missed appointments at an outpatient clinic in Australia	Appointment reminder	One message per scheduled appointment	Three business days before scheduled appointment	Intervention produced statistically significant decrease in missed appointment rate
Downing et al. (2013)	76	RCT	Manually sent text message reminder designed to increase chlamydia re-testing rates among young adults in Australia	Re-testing reminder	One message per scheduled appointment	Delivered the Monday before a scheduled appointment	Intervention produced statistically significant increase in re-testing rates
Dowshen et al. (2013)	21	Quasi-experimental	Automated, personalized text message reminder designed to increase ART medication adherence for HIV positive adolescents and young adults in the United States	Medication adherence	Two messages per scheduled medication for 24 weeks	Individually customized based on medication schedule	Intervention produced increase in medication adherence
Eppright et al. (2014)	42	RCT	Automated text message reminders designed to increase oral hygiene among orthodontic patients (ages 11–19) at a University clinic in the United States	Tooth brushing reminder	One message per weekday; duration varied (mean of 5.44 months)	5:15 PM	Intervention produced statistically significant decreases in plaque index, bleeding index, and modified gingival index scores
	172 ^a	RCT	Automated text message reminder designed to decrease	Appointment reminder			

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Table 1 (continued)

Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Fairhurst and Sheikh (2008)	350	RCT	missed appointments at an outpatient primary care center in the United Kingdom	Medication adherence	One message per scheduled appointment	Between 8:00 AM and 9:00 AM, and 4:00 PM and 5:00 PM	Intervention produced decrease in missed appointment rate
Fang and Deng (2017)			Text message reminders designed to increase medication adherence for pulmonary tuberculosis patients in China		One message per day		
Farmer et al. (2014)	4,000 ^a	Quasi-experimental	Automated text message reminder designed to decrease missed appointments and increase cancellations ahead of time at sexual health and HIV clinics in the United Kingdom	Appointment reminder	One message per appointment	Two days before scheduled appointment	Intervention produced statistically significant decrease in missed appointments and increase in advance cancellations
Ferguson et al. (2015)	6	Quasi-experimental	Personalized, automated smartphone task completion reminders among individuals with TBI in the United Kingdom	Task reminder	One individually customized message per scheduled task	Five minutes before each scheduled task	Intervention produced a statistically significant improvement in task completion rates
Fischer et al. (2012)	47 ^a	Quasi-experimental	Automated text message reminder designed to increase treatment and medication adherence for adults with diabetes in the United States	Medication adherence	Three treatment adherence reminders per week for three months and three appointment reminders per scheduled appointment	Treatment adherence reminders: Monday, Wednesday, and Friday at 7:15 AM and appointment reminders: 7, 3, and 1 day before scheduled appointment	Intervention did not produce change in medication adherence but did increase frequency of blood glucose reading
Foley and O'Neill (2009)	709 ^b	Quasi-experimental	Automated text message reminder designed to decrease rate of missed appointments at an outpatient clinic in the United Kingdom	Appointment reminder	One message per scheduled appointment	One day before scheduled appointment	Intervention produced statistically significant decrease in missed appointments
Foreman et al. (2012)	580	Quasi-experimental	Automated text message reminder designed to increase medication adherence for individuals with chronic diseases in the United States	Medication adherence	Individually customized by participant	Individually customized by participant	Intervention produced statistically significant increase in medication adherence
Franklin et al. (2006)	90	RCT	Automated, personalized text message reminders designed to support and remind individuals of treatment goal for youth and adolescents with diabetes in the United Kingdom	Treatment reminder	One message per day for one year	Not described	Intervention produced statistically significant improvement in self-efficacy and treatment adherence
Garofalo et al. (2016)	105	RCT	Personalized, two-way, automated text message reminders designed to increase ART medication adherence among HIV-positive adolescents and young adults in the United States	Medication adherence	One reminder message and one follow-up message per day for six months	Timed to coincide with individual medication schedule	Intervention produced statistically significant increase in medication adherence
Gatwood et al. (2016)	43	RCT	Tailored, automated text message reminders designed to increase diabetes medication adherence among adults with uncontrolled diabetes in the United States	Medication adherence	One tailored text message per day for 90 days	Timed to coincide with first scheduled medication dose of the day	Intervention did not statistically significantly increase medication adherence but did increase perceived benefits and competence
Gengiah et al. (2014)	4	Quasi-experimental	Automated text message reminder sent by electronic medication dispenser designed to increase HIV prevention medication adherence in South Africa	Medication adherence	One message per use of medication	When medication dispenser is opened (up to twice per day)	Intervention produced increase in medication adherence
Georgette et al. (2017)	2920	Quasi-experimental	Customized, automated text message reminders designed to increase prescription coverage for South African adults (18+) taking anti-retroviral therapy (ART) medication	Medication adherence	One message per week	Not reported	Intervention produced statistically significant increase in prescription coverage
Geraghty et al. (2008)	8966	Quasi-experimental	Automated text message reminder designed to decrease missed appointments at an ear, nose, and throat (ENT) clinic in Ireland	Appointment reminder	One message per scheduled appointment	Three days before scheduled appointment	Intervention produced statistically significant decrease in missed appointment rate
	58	RCT					

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Table 1 (continued)

Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Goldstein et al. (2014)			Automated reminder sent by either smartphone app or electronic medication dispenser designed to increase medication adherence for older adults with heart failure in the United States	Medication adherence	One reminder per scheduled medication for 28 days	Individually customized based on medication schedule	Intervention did not produce change in medication adherence
Granholtm et al. (2012)	42	Quasi-experimental	Automated text message reminders designed to increase socialization and medication adherence and to decrease symptoms of auditory hallucinations among schizophrenic patients in the United States	Medication adherence	Three sets of four messages per day (Monday through Saturday) for 12 weeks	One set of messages each morning, afternoon, and evening	Intervention produced increase in medication adherence and social interactions and decrease auditory hallucinations
Gu et al. (2016)	48	RCT	Automated text messages designed to increase rate of stent removal during appropriate time-frame among patients undergoing endoscopic stent insertion at a hospital in China	Stent removal adherence	One message per month for four or six months (depending on stent guidelines)	Not reported	Intervention produced statistically significant improvement in stent removal adherence
Guy et al. (2013)	681 ^a	Quasi-experimental	Automated text message reminder designed to increase rate of chlamydia re-screening among teens and young adults in Australia	Appointment reminder	One message per scheduled appointment	Individually customized with provider after initial testing appointment	Intervention produced statistically significant increase in re-screening rate
Haji et al. (2016)	1116	RCT	Automated text message reminders designed to increase infant vaccination rate at an outpatient clinic in Kenya	Vaccine reminder	Two messages per appointment for two appointments	Two days before and on day of scheduled appointment	Intervention produced increase in vaccination rate
Hanauer et al. (2009)	29	Quasi-experimental	Automated text message reminders designed to increase treatment adherence for youth and young adults with diabetes in the United States	Treatment adherence	Individually customized by participant	Individually customized by participant	Intervention produced statistically significant increase in treatment adherence
Hardy et al. (2011)	19	RCT	Automated, customized text message reminder designed to increase ART medication adherence for adults with HIV in the United States	Medication adherence	Daily messages, customized to coincide with medication schedule	Individually customized based on medication schedule	Intervention produced increase in medication adherence
Hart and Vaccaro (2017)	8	Pilot RCT	Participant created automated text message reminders designed to increase goal-related activity in individuals with traumatic brain injury (TBI) in the United States	Behavioral intention reminder	Individually customized; majority received half their messages every other day for eight weeks	Individually customized	Intervention produced statistically significant group by time interaction for community activity and social relations
Hirst et al. (2017)	8269	RCT	Automated text message reminder designed to increase return of colorectal cancer screening kit among adults (ages 60–74) in London	Screening reminder	One message	Seven weeks into screening window	Intervention produced increased on-time return of kit and amount of first-time invitees that completed their screening
Hofstetter et al. (2015a, 2015b)	5304	RCT	Automated informational and interactive text message reminders for urban and low-income parents to take their child to receive the influenza vaccination in the United States	Vaccine reminder	Five messages per week for two months and two messages during the third month	Individually customized, typically sent during the day	Intervention produced statistically significant increase in vaccination completion
Hofstetter et al. (2015a, 2015b)	2054	RCT	Automated text messages to help patients schedule vaccinations and a reminder text designed to increase appointment attendance for 9.5–10.5 month old infants from four urban academically affiliated pediatric clinics in the United States	Vaccine reminder and appointment reminder	Up to three, weekly, scheduling reminder texts and one appointment reminder text	Appointment reminder: two days before scheduled appointment	Intervention produced statistically significant increase in scheduling rate and on-time vaccination completion
Hou et al. (2010)	73	RCT	Automated text message reminder designed to increase oral contraception pill adherence among females in the United States	Medication reminder	One message per day for three months	Individually customized based on medication schedule	Intervention did not produce a change in medication adherence
Huang et al. (2013)	1198	RCT	Automated text message reminders designed to increase medication adherence among	Medication adherence	One message per medication per day for seven days	Researcher selected; not otherwise specified	Intervention produced decrease in delayed medication doses and

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Table 1 (continued)

Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Huang et al. (2017)	1312	RCT	adult outpatients released from a hospital in China with a prescription lasting 7+ days Automated text message reminders designed to decrease missed and delayed medication doses among Taiwanese adults (20+)	Medication adherence	One message per day for seven days	Morning	increase in overall medication adherence Intervention produced statistically significant decrease in delayed medication doses and increased overall medication adherence
Johnson et al. (2016)	98	RCT	Customized, automated text messages designed to increase medication adherence for outpatient adolescents with asthma in the United States	Medication adherence	Individually customized messages daily for three weeks	Individually customized	Intervention produced statistically significant improvement in medication adherence, quality of life, and self-efficacy
Jordan et al. (2015)	18,186	Quasi-experimental	Automated education and reminder messages designed to increase vaccination rates for infants under one year old in the United States	Vaccine reminder	Up to three messages	Not reported	Intervention produced increase in odds of vaccination rate for mothers intending to vaccinate infants and for mothers not intending to
Junod Perron et al. (2013)	6450	RCT	Automated text message reminder designed to decrease missed appointment rate among patients at an outpatient academic primary care clinic in Switzerland	Appointment reminder	One message per scheduled appointment	24 hours before scheduled appointment	Intervention did not produce change in appointment attendance rate
Kamal et al. (2015)	200	RCT	Tailored, automated text message medication adherence reminders and informational messages for adult stroke survivors in Pakistan	Medication adherence	One daily reminder message and two informational messages per week for two months	Reminders individually customized based on medication schedule; informational messages sent on Wednesday and Saturday	Intervention produced statistically significant improvement in medication adherence and decrease in diastolic blood pressure
Keränen and Liikkanen (2013)	45	Quasi-experimental	Automated text message reminder designed to increase rate of Parkinson's medication adherence among adults in Finland	Medication adherence	One reminder per scheduled medication for 24 weeks	Individually customized based on medication schedule	Intervention produced increase in medication adherence
Kerrison et al. (2015)	2240	RCT	Automated text message reminder designed to increase rate of first routine breast cancer screening among women in the United Kingdom	Appointment reminder	One message per scheduled appointment	48 hours before scheduled appointment	Intervention produced statistically significant increase in breast cancer screening rate
Khorshid et al. (2014)	116	RCT	Automated text message reminders designed to increase iron supplementation adherence among pregnant women (gestational age: 14–16 weeks) in Iran	Medication adherence	3 reminders and 4 educational messages per week for 12 weeks	Not reported	Intervention produced statistically significant improvement in medication adherence
Kim et al. (2015)	205	RCT	Tailored, automated text message reminder designed to help promote weight loss among worksite workers in Korea	Exercise reminder	Three messages per week for six months	Morning	Intervention produced decrease in weight
Kodama et al. (2016)	28	Quasi-experimental	Automated text message reminders including informational links to social welfare services and appointment reminders designed to promote increased help-seeking behaviors among individuals with high levels of suicidal ideation among outpatient psychiatric patients in Japan	Supportive messaging and appointment reminder	Two messages per week for six months	12:30 PM every Monday and Thursday	Intervention produced increase in appointment attendance and in seeking support for suicidal ideation
Kollmann et al. (2007)	10	Quasi-experimental	Automated text message reminder designed to increase treatment adherence among adults with diabetes in Austria	Treatment adherence	One message per day (if less than three blood glucose measurements had been received) for three months	In the evening	Intervention produced statistically significant improvement in metabolic control
Koshy et al. (2008)	9,959 ^a	Quasi-experimental	Automated text message reminder designed to decrease missed appointments at a	Appointment reminder	One message per scheduled appointment	One day or four days before scheduled appointment	Intervention produced a decrease in missed appointment rate

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Table 1 (continued)

Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Kunigiri et al. (2014)	1819	RCT	hospital outpatient clinic in the United Kingdom A reminder by either mail, call, or automated text message designed to decrease missed appointments in an outpatient psychiatric clinic in the United Kingdom	Appointment reminder	Mail: one letter; call: up to 2 attempts; text: 2 messages	Mail: 2 weeks prior to appointment; call: 1 week prior to appointment; text: 14 days and 2 days prior to appointment	Intervention did not produce change in appointment attendance
Leong et al. (2006)	964	RCT	Manually entered text message reminder designed to increase follow-up appointment attendance at a primary care clinic in Malaysia	Appointment reminder	Up to three reminders (if no response) per scheduled appointment	24 to 48 hours before scheduled appointment	Intervention produced statistically significant increase in appointment attendance rate
Lewis et al. (2013)	46	Quasi-experimental	Automated, tailored text message reminders designed to increase medication adherence for people with HIV in the United States	Medication adherence	One to three per day based on medication regimen	Individually customized based on medication schedule	Intervention produced increase in medication adherence
Liew et al. (2009)	769	RCT	Automated text message reminder designed to decrease missed appointment rate adults with diabetes in Malaysia	Appointment reminder	One message per scheduled appointment	24 to 48 hours before scheduled appointment	Intervention produced statistically significant decrease in missed appointment rate
Lin et al. (2012)	258	RCT	Automated text message reminder designed to increase appointment attendance rate among children with pediatric cataracts in China	Appointment reminder	Two reminders per scheduled appointment	Four days and one day before scheduled appointment	Intervention produced statistically significant increase in appointment attendance rate
Linnemayr et al. (2017)	332	RCT	Automated text message reminders designed to increase medication adherence among HIV-positive adolescents and young adults (ages 15–22) in Uganda	Medication adherence	One message per week for 48 weeks	Sunday at 9 AM	No statistically significant difference in medication adherence
Liu et al. (2017)	6989	RCT	Automated text message reminders designed to decrease missed appointments among adult outpatients scheduled for an MRI in the United States.	Appointment reminder	One message per scheduled appointment	One day before scheduled appointment	Intervention produced statically significant decrease in missed attendance but did not impact appointment punctuality
Ludlow et al. (2009)	126	Quasi-experimental	Automated reminders (email or SMS) designed to increase treatment adherence for individuals with irritable bowel syndrome in the United Kingdom	Treatment adherence	Up to three messages per scheduled appointment	On Monday, one week before appointment, the week of the appointment, and the week after	Intervention produced increase in treatment adherence
Lund et al. (2012)	2550	RCT	Automated text message reminder designed to increase appointment attendance among pregnant women in Zanzibar	Appointment reminder	Two messages per month before gestational week 36, two messages per week after	Not described	Intervention produced a statistically significant increase in skilled delivery attendance
Lund et al. (2014)	2550	RCT	Automated text message reminders designed to increase ante-natal doctors visits for pregnant women in Zanzibar	Appointment reminder	Approx. 2 messages per month from enrollment until gestational week 36; approx. 2 messages per week from gestational week 36–6 weeks after delivery	Individually customized	Intervention produced statistically significant increase in appointment attendance
Lv et al. (2012)	71	RCT	Automated text message reminder designed to increase medication adherence among individuals with asthma in China	Medication adherence	Two messages per day for 12 weeks	At 10:00 AM and 8:00 PM	Intervention produced statistically significant increase in quality of life and medication adherence
Maduka and Tobin-West (2013)	104	RCT	Automated text message reminders designed to increase medication adherence among non-treatment adherent HIV/AIDS patients in Nigeria	Medication adherence	Two messages per week for four months	Monday and Thursday mornings	Intervention produced statistically significant increase in medication adherence and CD4+ cell count
Matheson et al. (2014)	37	Quasi-experimental	Automated text message reminders designed to increase vaccine completion at optimal time among youth (ages 12–22) at an urban outpatient clinic in the United States	Vaccine adherence	Three messages per dose	Seven days before dose, on dose date, seven days after dose	Intervention produced increase in vaccination completion rate

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Table 1 (continued)

Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Mao et al. (2008)		Quasi-experimental	Automated text message reminder designed to increase medication adherence for hospital outpatients in China	Medication reminder	One message per day for up to 19 days	10 minutes before scheduled medication	Intervention produced increase in medication adherence
Mbuagbaw et al. (2012)	200	RCT	Automated text message reminders designed to increase medication adherence among HIV-positive adults in Cameroon	Medication adherence	One message per week for six months	Wednesday at 9 AM	Intervention did not find change in medication adherence
McInnes et al. (2014)	20	Quasi-experimental	Automated text message reminder designed to decrease missed appointments at a medical center among homeless veterans in the United States	Appointment reminder	Two messages per appointment for eight weeks	Five days and 2 days before scheduled appointment	Intervention produced decrease in missed appointments
McIver et al. (2016)	704	Quasi-experimental	Automated text message reminders designed to increase rate of Hepatitis B vaccination completion in Australia	Vaccine reminder	One message per scheduled appointment	One day before scheduled appointment	Intervention did not produce a significant difference in vaccine completion rate
Milne (2010)	112,194 ^a	Quasi-experimental	Automated text message reminder designed to decrease missed appointment rate at a consultant outpatient clinic in the United Kingdom	Appointment reminder	One reminder per scheduled appointment	Two days before scheduled appointment	Intervention produced a decrease in missed appointment rate
Miloh et al. (2009)	41	Quasi-experimental	Automated text message reminder designed to increase medication adherence for youth and adolescents after receiving a liver transplant in the United States	Medication adherence	Individually customized based on medication schedule	Individually customized based on medication schedule	Intervention produced statistically significant increase in medication adherence as measured by mean tacrolimus level
Miloh et al. (2017)	51	RCT	Automated, individualized text message reminder designed to increase medication adherence among children with inflammatory bowel disease in the United States	Medication adherence	Individually customized	Individually customized	Intervention produced statistically significant increase in medication adherence
Modrek et al. (2014)	465	RCT	Automated text message reminder designed to increase rate of malaria rapid diagnostic test among adults having purchased an anti-malarial drug in Nigeria	Medication adherence	One message	One day after purchasing anti-malarial drug	Intervention produced statistically significant increase in medication adherence
Montes et al. (2012)	251	RCT	Automated text message reminder designed to increase medication adherence for individuals with schizophrenia in Spain	Medication adherence	One message per day for three months	At 11:00 AM or 2:00 PM	Intervention produced statistically significant increase in medication adherence
Moore et al. (2015)	50	RCT	Personalized, automated HIV medication reminders for HIV + individuals with co-occurring bipolar disorder in the United States	Medication adherence	One or two per day (depending on medication regimen) for 30 days	Individually customized based on medication schedule	Intervention produced statistically significant improvement in taking medication on time
Morris et al. (2015)	1557	RCT	Reminder either by mail, email, or automated text message sent to parents of adolescents not up-to-date on vaccinations in the United States	Vaccination reminder	Up to 3 reminders: 1st sent 2 weeks after enrollment, 2nd sent 3 months after, 3rd sent 3 months after	Individually customized and based on the adolescent being up-to-date on vaccinations or not	Intervention produced statistically significant improvement in vaccination completion
Muller et al. (2016)	37	RCT	Tailored, automated text message reminders designed to increase exercise among older Malaysian adults (55–70) that do not exercise regularly	Exercise reminders	Five messages per week for 12 weeks	Between 8 and 11 AM	Intervention produced increase in exercise
Muller et al. (2017)	2386	RCT	Automated text message reminders designed to increase colorectal cancer screening rates among Alaska Natives and American Indians	Appointment reminder	Up to three messages	Day 1, day 31, and day 60	Intervention produced statistically significant increase in screening completion rate
Murray et al. (2015)	117	RCT	Automated text message reminders designed to increase attendance and completion of a parent training program in the United States	Attendance reminder	One message per week for nine weeks	One day before a scheduled class	Intervention produced statistically significant improvement in training completion rate
Narring et al. (2013)	999	RCT	Automated text message reminder designed to decrease missed appointment rate among	Appointment reminder	One message per scheduled appointment	Between 8 and 11 AM the day before scheduled appointment	Intervention produced decrease in missed appointment rate

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Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Nelson et al. (2011)	318	RCT	youth (ages 12–24) clinic outpatients in Switzerland Automated text message reminder designed to decrease failure to attend rate at a pediatric dental University clinic in the United States	Appointment reminder	One message per scheduled appointment	48 hours before scheduled appointment	Intervention found that phone reminders were more effective than text messages
Niederhauser et al. (2015)	57	RCT	Automated text message reminders designed to remind parents to complete vaccination for their infant children in the United States	Vaccine reminder	Six total messages	Based on age of infant (messages at: 4, 7, 12, 15, 20, and 23 weeks)	Intervention did not find a change in vaccination completion rate
Nundy et al. (2013a, 2013b)	15	Quasi-experimental	Automated educational and medication adherence reminder text messages designed for adults taking medication for heart failure in the United States	Educational, medication adherence, and appointment reminders	One medication reminder per day for 30 days; 1 appointment reminder 2 days before scheduled appointment	Individually customized based on medication and appointment schedule	Intervention produced increase in medication adherence
Nundy et al. (2013a, 2013b)	18	Quasi-experimental	Automated text message reminders designed to increase treatment adherence for adults with diabetes in the United States	Treatment adherence	Daily, twice a week, or once a week	Not described	Intervention produced increase in treatment adherence, self-efficacy, and social support
Nyatsanza et al. (2016)	539	Quasi-experimental	Personalized, automated text messages designed to increase STI retesting rates among individuals (ages 15–61) in the United Kingdom	Appointment reminder	One message	Six weeks after initial testing	Intervention produced statistically significant improvement in STI retesting rates
Odeny et al. (2012)	1200	RCT	Automated text message reminders designed to increase appointment attendance among adult (18+) male circumcision patients in Kenya	Appointment reminder	One message per day for seven days	Not reported	Intervention produced statistically significant increase in appointment attendance rate
Odeny et al. (2014)	984	RCT	Automated text message reminder designed to deter early resumption of sexual activity after male circumcision in Kenya	Medical safety reminder	One message per day	14 researcher selected days; timing individually customized	Intervention did not reduce rate of early resumption of sexual activity
O'Leary et al. (2015)	4587	RCT	Automated, two-way text messages designed to increase rate of vaccination completion among adolescents in the United States	Vaccine reminder	Up to four messages over six weeks	Initial reminder followed by additional message every two weeks	Intervention produced statistically significant increase in completing all needed services and vaccinations; and in completing any vaccination
Orrell et al. (2015)	230	RCT	Automated text message reminders designed to increase ART medication adherence and decrease treatment interruptions among ART-naïve individuals in South Africa	Medication adherence	One message per late dose for 48 weeks	30 minutes after missed dose	Intervention produced statistically significant decrease in treatment interruptions
Park et al. (2014)	84	RCT	Automated educational only or education and reminder messages designed to increase medication adherence for patients with coronary heart disease in the United States	Medication adherence	14 educational messages; 2 reminder messages per day for 30 days	Individually customized based on medication schedule	Intervention produced statistically significant increase in number of doses completed and doses completed on time
Park et al. (2015)	280	RCT	Automated text message reminder designed to increase completion of second medication dose among adult (18+) outpatients at a University hospital in Korea	Medication adherence	One message	Individually customized	Intervention produced statistically significant increase in medication adherence
Pena-Robichaux et al. (2010)	25	Quasi-experimental	Automated text message reminder designed to increase treatment adherence for adults and adolescents with atopic dermatitis in the United States	Treatment adherence	One message per day: treatment reminder three times per week, educational message four times per week	Between 7:00–9:00 AM and 4:00–6:00 PM	Intervention produced statistically significant improvements in treatment adherence, self-care behaviors, skin severity, and quality of life
Perry (2011)	447 ^a	Quasi-experimental	Automated text message reminder designed to decrease missed appointment rate at a	Appointment reminder	One message per scheduled appointment	One day before scheduled appointment	Intervention produced statistically significant decrease in missed appointment rate

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Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Pijnenborg et al. (2007)	5	Quasi-experimental	dental clinic in the United Kingdom Automated text message reminder designed to increase goal-directed behavior, medication adherence, and appointment attendance for individuals with schizophrenia in the Netherlands	Medication reminder and appointment reminder	Customized based on participant preference	Customized based on participant preference	Intervention produced increase in medication adherence and appointment attendance
Pijnenborg et al. (2010)	47	RCT	Automated text message reminder designed to increase functioning for individuals with schizophrenia in the Netherlands	Treatment adherence	Two message prompts per day per scheduled goal activity	One hour and 10 min before scheduled activity	Intervention produced increase in functioning
Pop-Eleches et al. (2011)	428	RCT	Automated text message reminder designed to increase ART medication adherence for individuals with HIV in Kenya	Medication adherence	One message per day or week	At 12 PM	Intervention produced statistically significant increase in medication adherence
Porto-Ferreira et al. (2017)	1405	RCT	Automated text message reminder designed to increase rate of return to blood center among serologically-active blood donors in Brazil	Appointment reminder	One phone call, letter, or text	15 days after blood draw	Phone reminder was most effective intervention, followed by text, and letter
Prasad and Anand (2012)	206 ^a	RCT	Automated text message reminder designed to increase appointment attendance at a dental clinic in India	Appointment reminder	Two reminders per schedule appointment	24 hours before scheduled appointment and morning of scheduled appointment	Intervention produced statistically significant increase in appointment attendance rate
Pratap et al. (2015)	Total not reported	Quasi-experimental	Automated text message reminders designed to decrease cancellations on the day of a scheduled surgery in the United States	Surgery reminder	One reminder of scheduled surgery time	The night before scheduled surgery	Intervention produced significant reduction in appointment cancellations
Raiff et al. (2016)	3	Quasi-experimental	Personalized, automated text message reminders sent by electronic medication dispenser if scheduled diabetes medication is not taken among adults with Type 2 diabetes in the United States	Medication adherence	One message per missed medication	Personalized by medication time	Intervention produced increase in medication adherence
Raifman et al. (2014)	1140	RCT	Automated reminder and encouraging text messages designed to increase rate of medication adherence among adults (18+) receiving malaria treatment in Ghana	Medication adherence	Two messages per day for three days	8 AM and 7 PM	Intervention produced statistically significant increase in medication adherence
Rand et al. (2015)	2050	RCT	Automated text message reminder delivered to parents on adolescents, designed to increase HPV dose 1 vaccination rates for publicly insured adolescents in the United States	Vaccination reminder	Up to 4 messages: initial notice of enrollment and reminder of dose 1, 2, and 3	Not described	Intervention produced statistically significant increase in vaccination completion rate
Rand et al. (2017)	135	RCT	Automated text message reminders designed to increase receipt rate of third dose of human papillomavirus (HPV) vaccine and HPV vaccination rates in the United States	Vaccine reminder	One message per week for up to three weeks	Beginning one week before each dose was due	Text message intervention produced statistically significant improvement in vaccination completion
Regan et al. (2017)	12,354	RCT	Automated text message reminder designed to increase flu vaccine completion among unvaccinated high risk flu patients in Australia	Vaccine reminder	One tailored message	Not reported	Intervention produced statistically significant improvement in vaccination completion
Richman et al. (2016)	264	RCT	Automated electronic (text message and email) appointment reminders and educational messages designed to increase rates of HPV vaccination completion and increase HPV knowledge among female college students (ages 18–26) in the United States	Vaccine reminder	One message per month for 7 months (4 educational, 2 appointment reminders, 1 survey reminder)	Timed to coincide with scheduled appointments	Intervention did not significantly improve vaccination completion but did significantly increase participant knowledge
Rohman et al. (2015)	65,567 ^a	RCT	Automated text message reminder designed to decrease missed appointment rates at a	Appointment reminder	One message per scheduled appointment	One week before scheduled appointment	Intervention produced statistically significant

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Table 1 (continued)

Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Shaw et al. (2013)	14	Quasi-experimental	hospital-based orthopedic clinic in the United Kingdom Automated text message reminder designed to help participants lose weight among obese patients in the United States	Weight loss reminder	One message per day for one month	At 9:00 AM	decrease in missed appointment rate Intervention produced decrease in participant weight
Sims et al. (2012)	1,256 ^a	Quasi-experimental	Automated text message reminder designed to increase appointment attendance at a mental health clinic in the United Kingdom	Appointment reminder	7 and 5 or 7 and 3 days before scheduled appointment	At 6:00 PM	Intervention produced statistically significant increase in appointment attendance rate
Sly et al. (2014)	24	Quasi-experimental	Automated text message reminder designed to increase completion of colonoscopy among minority patients eligible for a colonoscopy in the United States	Appointment reminder	Two reminder messages	14 days and 3 days before scheduled appointment	Intervention produced increase in colonoscopy completion rate
Smith et al. (2015)	301	RCT	Automated text message reminder designed to increase completion rate of at-home chlamydia retesting in Australia	Testing reminder	One reminder to complete retest	Three months after initial chlamydia diagnosis	Intervention produced statistically significant improvement in chlamydia retest rate
Spohr et al. (2015)	71	RCT	Automated electronic (email or text message) substance use related goal reminders among adult (ages 19–62) probationers in the United States	Goal reminder	One message per reminder	Individually customized	Intervention produced statistically significant increase in goal selection and appointment attendance rate
Steiner et al. (2016)	8804	RCT	Mobile phone reminders: an interactive voice response (IVR) call and a follow up automated text message reminder designed to increase appointment attendance at an outpatient primary care clinic in the United States	Appointment reminder	One message for participants with cell-phones	One business day before scheduled appointment	Intervention produced statistically significant increase in appointment attendance
Stockwell et al. (2012a, 2012b) ¹	Study 1: 196 Study 2: 174	RCT	Automated text message reminders designed to increase rates of child vaccination completion among urban and low-income parents in the United States	Vaccine adherence	Study 1: up to five messages; Study 2: up to three messages	Study 1: Weeks 1, 2, 3, 6, and 7; Study 2: Not reported	Study 1 and Study 2: Intervention produced statistically significant increase in vaccination completion rate
Stockwell et al. (2012a, 2012b) ²	7574	RCT	Automated text message reminders designed to increase vaccination adherence among low-income children and adolescents at community-based clinics in the United States	Vaccine adherence	Up to five messages	One message per week for up to five week	Intervention produced increase in vaccination completion rate
Stockwell et al. (2014)	1143	RCT	Automatic text message reminder designed to increase completion rate of influenza vaccination among urban and low-income pregnant women in the United States	Vaccination reminder	Two reminder messages	Individually customized based on scheduled appointments	Intervention produced statistically significant increase in vaccination completion rate and women in the third trimester exhibited the greatest intervention effect
Stockwell et al. (2015)	660	RCT	Automated text message reminders (educational + reminder vs reminder only) designed to increase second dose of influenza vaccination rates among low-income families in the United States	Vaccination reminder	Up to three messages	1) Three days before dose was due, 2) on day dose was due, 3) 2 weeks after dose was due	Intervention produced statistically significant increase in vaccination completion rate
Stoner et al. (2015)	37	RCT	Automated text message reminder designed to increase medication adherence for individuals with alcohol use disorder in the United States	Medication adherence	One message per day for eight weeks	Not described	Intervention did not produce increase in medication adherence
Strandbygaard et al. (2010)	22	RCT	Automated text message reminder designed to increase asthma treatment adherence in Denmark	Treatment adherence	One message per day for eight weeks	At 10 AM	Intervention produced statistically significant increase in treatment adherence
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Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Suffoletto et al. (2015)			Tailored, automated text messages designed to increase medication adherence among patients discharged from a hospital in the United States with an antibiotic prescription	Medication adherence	Individually customized	Individually customized	Intervention produced increase in medication adherence
Sumari-de Boer et al. (2016)	10	Quasi-experimental	Automated text message reminders sent by electronic medication dispenser if scheduled medication is not taken for HIV and TB patients in Tanzania	Medication adherence	One message per missed dose for three months	Three hours after missed dose	Intervention produced increase in medication adherence
Taylor et al. (2012)	675	RCT	Automated or manual text message reminder designed to decrease missed appointment rate at a physical therapy outpatient clinic in Australia	Appointment reminder	One message per schedule appointment	24 to 48 hours before scheduled appointment	Intervention produced statistically significant decrease in missed appointment rate
Thakkar et al. (2016)	710	RCT	Automated text message reminders designed to increase recreational physical activity and target physical activity levels among individuals in Australia with coronary heart disease	Medical treatment adherence	One message per day, four times per week (days randomly selected) for six months	Between 10 AM and 4 PM	Intervention produced statistically significant increase in exercise activity
Thomas et al. (2017)	95	RCT	Automated text message reminders designed to increase appointment attendance rate among outpatients with first-episode psychosis in Nigeria	Appointment reminder	Two messages	One message sent five days and three days before first appointment	Intervention produced improvement in appointment attendance
Thomsen et al. (2017)	150	RCT	Automated text message reminders designed to decrease daily sitting time among patients with rheumatoid arthritis in Denmark	Medical compliance reminder	Not reported	Not reported	Intervention produced statically significant reduction in daily sitting time
Ting et al. (2012)	70	Quasi-experimental	Automated text message reminder designed to increase appointment attendance and medication adherence for adolescents with lupus in the United States	Appointment reminder and medication adherence	7, 3, and 1 day(s) before scheduled appointment, and one or two medication reminders per day	Individually customized based on medication schedule	Intervention produced increase in appointment attendance rate but did not find a change in medication adherence
Tolonen et al. (2014)	165	RCT	Automated text message reminder designed to increase rate of appointment attendance at a medical clinic in Finland	Appointment reminder	One reminder message	Delivered two days before scheduled appointment	Intervention produced increase in appointment attendance rate
Trent et al. (2015)	100	RCT	Automated text message reminder designed to increase appointment attendance among adolescent and young adult women (ages 13–21) in the United States	Appointment reminder	One reminder message per day	72 hours before appointment and every 24 until appointment or until message response	Intervention produced statistically significant increase in return for first clinic appointment
Van Ryswyk et al. (2015)	276	RCT	Automated text message reminders designed to increase attendance for testing among mothers with gestational diabetes in Australia	Appointment reminder	Intervention group: three messages; Control group: one message	Intervention: six weeks, three months, and six months post-partum; Control: six months post-partum	Intervention produced increase in appointment attendance rate
Vervloet et al. (2012)	104	RCT	Automated text message reminder designed to increase medication adherence among individuals with diabetes in the Netherlands	Medication reminder	One message per day	Delivered if patient had not opened medication canister	Intervention produced statistically significant increase in medication adherence
Vervloet et al. (2014)	161	RCT	Automated text message reminder designed to increase refill adherence among individuals with Type 2 diabetes and suboptimal medication adherence in the Netherlands	Medication adherence	One message per missed medication dose for one year	Individually customized	Intervention produced statistically significant increase in refill adherence
Vidal et al. (2014)	12,786	Quasi-experimental	Automated text message reminder designed to increase appointment attendance among 50–69 year old women in Spain	Appointment reminder	One message	Three days before scheduled appointment	Intervention produced statistically significant increase in appointment attendance rate
Vilella et al. (2004)	4,589 ^a	Quasi-experimental	Automated text message designed to increase vaccination	Vaccination reminder	One message per scheduled appointment	Few days before scheduled appointment	Intervention produced increase in vaccination adherence rate

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Study	Sample size	Study design	Intervention description	Goal of text message	Rate of messaging	Timing of message	Intervention outcome
Wald et al. (2014)	303	RCT	adherence for individuals in Spain Automated, two-way text messaging designed to increase medication adherence among patients receiving cardiovascular preventative treatment in the United Kingdom	Medication adherence	Daily messages for first 2 weeks; every other day for next 2 weeks; once a week for final 22 weeks	Individually customized	Intervention produced statistically significant increase in medication adherence
Wang et al. (2014)	50	RCT	Automated text message reminders designed to improve increase medication adherence and improvement appointment attendance rates among outpatients with allergic rhinitis in China	Medication adherence and appointment reminder	1 message per day for 30 days	At 7 AM, Monday–Friday and at 9 AM on Saturday and Sunday	Intervention produced statistically significant improvement in appointment attendance, medication adherence, and symptom severity
Wolff et al. (2016)	95	RCT	Automated text message reminders designed to increase follow-up appointment attendance rate among adolescents hospitalized with pelvic inflammatory disease in the United States	Appointment reminder	Four personalized messages over four days	Sent on days 2, 3, 4, and 5 after discharge from ED. Sent between 3:30 and 4:30 PM during the week and at 10 AM on the weekend	Intervention produced statistically significant improvement in follow-up appointment attendance
Yang et al. (2016)	209	RCT	Personalized, automated text message designed to increase follow-up appointment attendance following trabeculectomy at a hospital in China	Appointment reminder	One text message	Three days before scheduled appointment	Intervention produced statistically significant increase in follow-up appointment attendance
Yudin et al. (2017)	317	RCT	Automated text message reminders designed to increase influenza vaccination completion among pregnant women in Canada	Vaccine reminder	Two messages per week for four weeks	Not reported	Intervention produced increase in vaccination completion

RCT – randomized control trial.

^a Total number of appointment reminders sent.

Kerrison et al., 2015; Koshy et al., 2008; Leong et al., 2006; Liew et al., 2009; Lin et al., 2012; Liu et al., 2017; Lund et al., 2012; Lund et al., 2014; McInnes et al., 2014; Milne, 2010; Muller et al., 2017; Murray et al., 2015; Narring et al., 2013; Nundy et al., 2013a, 2013b; Nyatsanza et al., 2016; Odeny et al., 2012; Perry, 2011; Pijnenborg et al., 2007; Prasad and Anand, 2012; Pratap et al., 2015; Rohman et al., 2015; Sims et al., 2012; Sly et al., 2014; Steiner et al., 2016; Taylor et al., 2012; Thomas et al., 2017; Ting et al., 2012; Tolonen et al., 2014; Trent et al., 2015; Van Ryswyk et al., 2015; Vidal et al., 2014; Wolff et al., 2016; Yang et al., 2016).

Six of the eight studies that did not find improved outcomes for individuals receiving SMS reminders reported neutral results. Of the six studies, one reported being underpowered to assess appointment attendance differences (Fischer et al., 2012); two found no significant difference between a phone call, mailed, and SMS reminder (Bos et al., 2005; Kunigiri et al., 2014); one found no significant difference between a mailed reminder and a mailed reminder in addition to a SMS reminder (Delgado et al., 2015); one found no significant difference between a SMS reminder and no SMS reminder (Bellucci et al., 2017); and one found no significant difference between a telephone call and a SMS reminder (Junod Perron et al., 2013). The seventh study (Clough and Casey, 2014), found SMS appointment reminders were not significantly more effective than the control group at increasing intake appointment attendance at an outpatient training clinic. The results trended toward more participants receiving reminders dropping out before their intake appointment. Despite this, the authors still suggest that with further research SMS may prove to be a viable appointment reminder system. The eighth study (Nelson et al., 2011) found that phone reminders were more effective than SMS reminders at increasing pediatric dental appointment attendance. Despite this, the authors

suggested continuing to investigate the effectiveness of messages based on patient preference (i.e., sending text messages to individuals that prefer them as a reminder method). Kunigiri et al. (2014) found SMS reminders were not statistically significantly more effective than calls or mailed reminders. Yet, they suggest continuing to use SMS messages as an appointment reminder mechanism due to its ease and relative inexpensiveness.

3.6. Medication, treatment, and vaccination adherence

Of the studies reviewed, the most common application of SMS reminders is for medical compliance reminders. The term medical compliance reminders is used in this review to encompass reminders to follow a medication regimen (e.g., taking anti-retroviral therapy medication on time), to follow a non-medication treatment guideline (e.g., returning for sexually transmitted infection re-testing), and to complete vaccinations (e.g., fully immunizing infants). Ninety-seven of the 162 studies reviewed (59%) assessed the impact of SMS reminders on medical compliance reminders. Medication regimen adherence was the intervention outcome for 52 of these studies, non-medication treatment adherence was the intervention outcome for 24, and vaccination adherence was the intervention outcome for 21. Medical compliance reminders were found to improve (e.g., taking medication at a scheduled time, completing non-medication follow-up treatment, completing a vaccination regimen) when using an SMS-reminder intervention in 85% (83/97) of studies (Akhu-Zaheya and Shiyab, 2017; Anthony et al., 2015; Armstrong et al., 2009; Arora et al., 2012; Baker et al., 2015; Balato et al., 2013; Bangure et al., 2015; Berenson et al., 2016; Chow et al., 2015; Chung et al., 2015; Cocosila et al., 2009; da Costa et al., 2012; Davey et al., 2016; Dick et al., 2011; Downing et al., 2013;

Dowshen et al., 2013; Fang and Deng, 2017; Ferguson et al., 2015; Foreman et al., 2012; Franklin et al., 2006; Garofalo et al., 2016; Gengiah et al., 2014; Georgette et al., 2017; Granholm et al., 2012; Gu et al., 2016; Guy et al., 2013; Haji et al., 2016; Hanauer et al., 2009; Hardy et al., 2011; Hirst et al., 2017; Hofstetter et al., 2015a; Hofstetter et al., 2015b; Huang et al., 2017; Huang et al., 2013; Johnson et al., 2016; Jordan et al., 2015; Kamal et al., 2015; Keränen and Liikkanen, 2013; Khorshid et al., 2014; Kollmann et al., 2007; Lewis et al., 2013; Ludlow et al., 2009; Lv et al., 2012; Maduka and Tobin-West, 2013; Mao et al., 2008; Matheson et al., 2014; Miloh et al., 2009; Miloh et al., 2017; Modrek et al., 2014; Montes et al., 2012; Moore et al., 2015; Morris et al., 2015; Nundy et al., 2013b; Nundy et al., 2013a; O'Leary et al., 2015; Orrell et al., 2015; Park et al., 2014; Park et al., 2015; Pena-Robichaux et al., 2010; Pijnenborg et al., 2007; Pop-Eleches et al., 2011; Raiff et al., 2016; Raifman et al., 2014; Rand et al., 2015; Rand et al., 2017; Regan et al., 2017; Smith et al., 2015; Stockwell et al., 2014, 2015; Stockwell et al., 2012a; Stockwell et al., 2012b; Strandbygaard et al., 2010; Suffoletto et al., 2015; Sumari-de Boer et al., 2016; Thakkar et al., 2016; Thomsen et al., 2017; Vervloet et al., 2012, 2014; Vilella et al., 2004; Wald et al., 2014; Wang et al., 2014; Yudin et al., 2017).

Of the 14 studies that did not find a positive improvement, all but one reported the intervention had a neutral effect on participants. Three of the studies found that despite the medical compliance reminders not being more effective than the control group, the reminders still had benefits, including increasing medical knowledge (Richman et al., 2016), increasing self-efficacy in disease self-management (Gatwood et al., 2016), and increasing the rate of consecutive days taking medication (Stoner et al., 2015). Two of the studies reported being unpowered to find a statistically significant difference (Boker et al., 2012; Buis et al., 2017). Niederhauser et al. (2015) reported that their experimental group had more barriers to immunization than control and hypothesized that with a larger trial they might expect to find statistically significant results. One study reported most of their control group used their own reminder, potentially confounding the non-significant outcomes (Hou et al., 2010), and a second study hypothesized that many participants in the control group used their own reminder (although this was not formally assessed) (Mbuagbaw et al., 2012). Another study found that a phone call reminder was more effective than a SMS reminder at increasing treatment follow-up appointment completion (Porto-Ferreira et al., 2017). Two studies found both the treatment and control group had a significantly higher medication adherence and appointment attendance rate than typical (Burton et al., 2014; Goldstein et al., 2014); and another hypothesized that due to the length of their study, the novelty and benefit of a medication reminder may have worn off (Ting et al., 2012). Two studies did not find that SMS reminder helped increase rate of Hepatitis B and anti-retroviral therapy (ART) medication adherence and, in fact, displayed lower rates of adherence than no reminder or treatment as usual (respectively) (Linnemayr et al., 2017; McIver et al., 2016). Lastly, all studies that included a measure of feasibility and/or acceptability found positive results (e.g., Garofalo et al., 2016; Gengiah et al., 2014; Park et al., 2014), even if the intervention was not found to be statistically significant (e.g., Buis et al., 2017; Richman et al., 2016).

3.7. Miscellaneous messages

The remaining studies (15/162; 9%) that did not meet inclusion criteria as either an appointment or medical compliance reminder are grouped below by intervention outcome and briefly described.

3.7.1. Exercise

All six studies assessing the impact of SMS reminders on exercise and weight loss found improvements in exercise frequency, exercise consistency, or weight lost for individuals receiving reminders (Belton et al., 2013; Chen et al., 2017; Chen et al., 2016; Kim et al., 2015;

Muller et al., 2016; Shaw et al., 2013). These studies targeted a range of demographics, including age, from middle school students (mean age: 12) (Belton et al., 2013) to older adults (between 55 and 70 years old) (Muller et al., 2016); and location, Ireland (Belton et al., 2013), Malaysia (Muller et al., 2016), Taiwan (Chen et al., 2017; Chen et al., 2016), Korea (Kim et al., 2015), and the United States (Shaw et al., 2013). Four of the studies were randomized control trials (RCTs) (Belton et al., 2013; Chen et al., 2017; Kim, 2017; Muller et al., 2016) and the rest were quasi-experimental studies (Chen et al., 2016; Shaw et al., 2013).

3.7.2. Tooth brushing

Two studies assessed the impact of SMS reminders on the amount of plaque and level of oral hygiene. Bowen et al. (2015) found that SMS reminders helped adolescents and young adults (ages 11 to 18) decrease the amount of plaque on their teeth. Eppright et al. (2014) found that reminders helped adolescents and young adults (ages 11 to 19) improve their level of oral hygiene. Both studies were RCTs and were conducted at outpatient University clinics in the United States.

3.7.3. Diabetes

One study assessed the impact of reminders on perceived diabetes knowledge and injection skill among adults (ages 18 to 75) with diabetes mellitus in Turkey. The studies found reminders were effective at increasing patient-perceived diabetes knowledge and injection skill (Celik et al., 2015).

3.7.4. Schizophrenia

Pijnenborg et al. (2010) found SMS reminders helped inpatients and outpatients at a University clinic in the Netherlands with schizophrenia achieve a higher percentage of goal-directed behaviors (e.g., carrying out leisure activities). The study was quasi-experimental and utilized a wait list control.

3.7.5. Traumatic brain injury (TBI)

Hart and Vaccaro (2017) found SMS reminders helped individuals nearing discharge from intensive outpatient brain injury treatment with a TBI in the United States to more effectively implement goal-directed behaviors (e.g., seeking out appropriate social interaction). The study was an RCT with the control group receiving treatment as usual (TAU).

3.7.6. Suicidal ideation

Kodama et al. (2016) found SMS messages with informational links to social welfare services made psychiatric outpatients with high levels of suicidal ideation in Japan more likely to seek help when experiencing suicidal ideation. The study was quasi-experimental.

3.7.7. Substance use

Spohr et al. (2015) found SMS reminders helped adults (ages 19 to 62) on probation in the United States maintain substance use abstinence and initiate substance use treatment while in a criminal justice setting. The study was a RCT with the control group receiving no reminders.

3.7.8. Adult circumcision

Odeny et al. (2014) used SMS reminders to deter adult males in Kenya from resuming sexual activity too soon after circumcision. This basic intervention was not successful in reducing early resumption of sexual activity. The researchers suggest further investigation of SMS reminders should be paired with a behavioral intervention, citing the high likelihood that participants may not have understand post-operative instructions.

3.7.9. Smoking cessation

Abroms et al. (2014) used SMS reminders to help adults (mean age: 35.7 years old) in the United States stop smoking. The study found that the interactive, personalized reminders helped individuals abstain from

smoking statistically significantly more than the control group that received self-help TAU.

4. Discussion

The results of this literature review demonstrate SMS reminders can be effectively implemented worldwide (e.g., [Chen et al., 2008](#)) and in a variety of settings (e.g., [Stockwell et al., 2014](#)) to help improve health care services. SMS reminders show excellent promise as an automated support mechanism. The review found 86% (48/56) of appointment-reminder studies and 85% (83/97) of medical compliance reminder studies reported positive results associated with SMS messages. The reminders helped increase appointment attendance (e.g., [Guy et al., 2013](#)) and before-appointment cancellations (an unexpected outcome; e.g., [Steiner et al., 2016](#)), as well as decrease missed appointments (e.g., [Altuwajri et al., 2012](#)). By decreasing missed appointments and increasing advance cancellations, health care providers can save time and money, maintain uninterrupted care, and allow other patients to receive needed treatment ([da Costa et al., 2010](#); [Farmer et al., 2014](#); [Rohman et al., 2015](#); [Ting et al., 2012](#)). SMS reminders also helped increase the rate of medication adherence (e.g., [Montes et al., 2012](#)), non-medication treatment adherence (e.g., [Balato et al., 2013](#)), and vaccination completion (e.g., [Stockwell et al., 2014](#)).

SMS reminders showed promising results in studies of various diseases and conditions, including HIV, diabetes, heart problems, schizophrenia, skin problems, asthma, IBS, Parkinson's disease, psychosis, stroke, Hepatitis A and B, and breast cancer. A minority of studies did not find positive results. However, even these authors suggested that potential limitations such as small sample size ([Fischer et al., 2012](#)) or control group participants using their own reminders ([Hou et al., 2010](#); [Mbuagbaw et al., 2012](#)) may have confounded the results. The review found a single study investigating each of the following: IBS, Parkinson's disease, psychosis, stroke, breast cancer, and oral contraception. Given the lack of research in these areas, further research would be helpful to better understand the impact SMS reminders can have on these particular health care problems. However, given the composite effectiveness of SMS reminders for health care problems and the initial promising results described above, it seems probable SMS reminders are effective if implemented as a reminder mechanism.

4.1. Benefits of SMS reminders

SMS messages are relatively inexpensive, easily customized, automatically sent directly to individuals, and a part of many individuals' daily life. Given these attributes, it is not surprising many studies utilize SMS as a reminder to help improve health care services. SMS can function as a reminder both for recurring (e.g., daily medication adherence) and distal, one-time (e.g., to complete a follow-up vaccination two months after initial vaccination) behaviors. Clinics report major financial savings after implementing an automated, SMS-reminder system, and attribute the savings to the relative inexpensiveness of SMS reminders and the decreased rate of missed appointments (e.g., [Pratap et al., 2015](#); [Rohman et al., 2015](#)). SMS messages may also help individuals who need additional support or structure to remember things or to engage in a behavior (e.g., individuals with schizophrenia or a TBI) ([Hart and Vaccaro, 2017](#); [Pijnenborg et al., 2010](#)).

Medical professionals can use technology to help guide their treatment. With technology, they can receive more accurate information about treatment adherence when they are treating patients whose recall and self-report may not be accurate (e.g., [Boker et al., 2012](#)).

4.2. Potential consequences, risks, and drawbacks of SMS reminders

Patient confidentiality is frequently cited as a risk of using SMS in health care treatment (e.g., [Branson et al., 2013](#); [Downer et al., 2005](#)). While confidentiality is a risk, there are steps that can be taken to

mitigate the concern. These steps include: sending generic reminders (e.g., "See you next Thursday at 5"); informing individuals to open messages in a private location and delete messages after reading them; and suggesting individuals use password protection on their phones. However, SMS is an inherently insecure system technology. Unless an encrypted messaging application is being used, there is a possibility that any message sent can be read by someone other than the intended recipient—a risk that most individuals take on a daily basis (willingly or unwittingly).

One drawback is individuals not reading the messages they've received. A potential strategy to mitigate the possibility of messages being ignored is to utilize interactive or two-way messaging that elicits a response from message recipients. Another drawback is the possibility that recipients may become annoyed at receiving multiple messages over time. Note that none of the studies reviewed found SMS reminders caused adverse iatrogenic results.

4.3. Future directions

SMS reminders show great promise for use across the broad scope of health care services. This review found SMS reminders are highly effective as both an appointment and medical compliance reminder. Additionally, SMS reminders were found to be effective at prompting a number of other health behaviors, including self-medical examinations, socialization, and goal-directed behaviors. As of now, it is unclear what is the most effective dose of SMS reminders (i.e., timing, frequency, and total number of messages) and under what conditions should dosage be changed over time. It is likely dosage varies between individuals and is impacted by the perceived importance of the reminder (e.g., is it for something crucial to your health or for changing a behavior you aren't particularly motivated to change?). Additionally, the underlying mechanism that makes SMS reminders effective and aid prospective memory is not understood. Further research on these topics can help inform future implementations of reminders.

There is an existing body of research on the use of SMS to deliver interventions (e.g., [Haug et al., 2012](#)). Some studies have also investigated using SMS reminders as an adjunct (e.g., receiving an appointment reminder to continue attending the main intervention) to therapy (e.g., [Abroms et al., 2014](#)). However, very few studies have investigated the effectiveness of using SMS as a supportive adjunct to behavioral health treatment. One such study ([Aguilera et al., 2017](#)) used text messages not only as a reminder, but also as a support mechanism for racial/ethnic minority patients receiving cognitive-behavioral therapy (CBT) for depression. While the study did not find a statistically significant benefit of SMS, this is an area that may require further research to better understand how to implement reminders as a prompt to help support behavior change.

4.4. Limitations

While this review draws from many diverse sources, the data were synthesized using a narrative method rather than a meta-analysis, thus the findings cannot be used to recommend a preferred strategy for the use of SMS reminders in health care. The studies varied in methodological rigor, which may have impacted their results and biased the interpretation in this review. Studies were only selected from peer-reviewed, English-language journals, which may have restricted the findings.

5. Conclusion

The findings for the use of SMS reminders in health care treatment are very promising. A rapidly increasing body of literature on SMS reminders demonstrates the value of using SMS reminders. The results indicate SMS reminders provide an inexpensive, easily implemented, and automatable method to help increase medical compliance and

improve appointment attendance. Additionally, these results suggest SMS reminders may be helpful in improving prospective memory and supplementing behavior change interventions by reminding recipients to engage (or not engage) with behaviors they wish to change.

Declaration of conflicting interests

The authors declare that there is no conflict of interest with respect to the research, authorship, and/or publication of this article.

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