Iran Red Crescent Med J. 2016 May; 18(5):e25183. doi: 10.5812/ircmj.25183.

Published online 2016 April 30. **Review Article**

The Effectiveness of Mobile Phone Text Messaging in Improving Medication Adherence for Patients with Chronic Diseases: A Systematic Review

Roghayeh Ershad Sarabi,[1] Farahnaz Sadoughi,[1,*] Roohangiz Jamshidi Orak,[1] and Kambiz Bahaadinbeigy[2]

[1]Health Information Management Department, School of Management and Medical Information Sciences, Iran University of Medical Sciences, Tehran, IR Iran
[2]Medical Informatics Research Center, Institute of Futures Studies in Health, Kerman University of Medical Sciences, Kerman, IR Iran

[*]*Corresponding author*: Farahnaz Sadoughi, Health Information Management Department, School of Management and Medical Information Sciences, Iran University of Medical Sciences, Tehran, IR Iran. Tel: +98-2188794302, Fax: +98-2188883334, E-mail: sadoughi.f@gmail.com

Received 2014 November 22; **Revised** 2014 December 08; **Accepted** 2014 December 15.

Abstract

Context: Medication non-adherence is a commonly observed problem in the self-administration of treatment, regardless of the disease type. Text messaging reminders, as electronic reminders, provide an opportunity to improve medication adherence. In this study, we aimed to provide evidence addressing the question of whether text message reminders were effective in improving patients' adherence to medication.

Evidence Acquisition: We carried out a systematic literature search, using the five electronic bibliographic databases: PubMed, Embase, PsycINFO, CINAHL, and the Cochrane central register of controlled trials. Studies were included on the basis of whether they examined the benefits and effects of short-message service (SMS) interventions on medication adherence.

Results: The results of this systematic review indicated that text messaging interventions have improved patients' medication adherence rate (85%, 29.34). Included in the review, those who had problems with adherence, or those whom text messaging was most helpful had HIV, asthma, diabetes, schizophrenia and heart disease (73.5%). The period of intervention varied from 1 week to 14 months. The most common study design was randomized controlled trials (RCTs) (66%) carried out in the developed countries.

Conclusions: This study demonstrated the potential of mobile phone text messaging for medication non-adherence problem solving.

Keywords: Cellular Phones, Text Messaging, Medication Adherence, Chronic Disease, Review

1. Context

Medications adherence has been defined as the extent to which patients take medications as prescribed by their health care providers and decide on the treatment plan (1-3), while the lack of adherence to prescribed therapies is termed medication non-adherence (4). It is expected that 20% to 50% of patients do not take their medications as prescribed (2, 5). In 2003, the world health organization (WHO) identified medication non-adherence as the leading cause of preventable morbidity, mortality, and healthcare costs (3). Non-adherence is observed in all groups of patients where the self-management of treatment is necessary (3, 6), for example, adherence in patients with human immunodeficiency virus infections, arthritis, gastrointestinal disorders, and cancer have the highest levels, whereas it is the lowest in patients with pulmonary disease, diabetes mellitus, and sleep disorders (7, 8). In the United States, half of the 3.2 billion prescriptions dispensed annually are not followed by patients as prescribed (9, 10); this is even lower among patients with chronic diseases (2, 4, 11). Several reasons are documented for the non-adherence to medication; forgetting is one of the most common (3, 12). Health information technology (HIT) presents an opportunity to increase medication adherence rates, using electronic reminder systems (13). They seem to be an aid particularly for patients suffering from forgetfulness problems and those who are unintentionally non-adherent (14). Among examples are reminder messages that are automatically sent to a patient's mobile phone in the form of text messaging accessible on every model of mobile phones (15). Text messaging is relatively simple to use, its use is widespread, and its cost is low for users. Moreover, it is an appropriate intervention for a variety of health behavior changes (16, 17). Due to the extensive use of text message reminders as electronic reminders aiming at improving medication adherence, we need to achieve a better understanding of the effects of this method of reminding. Previous reviews have evaluated the effects of a text message reminder intervention on specific patient

populations; however, it has not been used in groups of patients who have chronic diseases (1, 18-23). According to the importance of medication adherence for patients with chronic diseases in that their poor adherence to drug therapy is associated with higher morbidity and mortality and an increase in healthcare costs and because of evidence indicating the positive impact of interventions on improvements in medication adherence (15), we decided to conduct a systematic review to provide new evidence on the effectiveness of text message reminders for these patients. Our main questions in this systematic review are: 1, what are published papers on effectiveness of SMS as reminders for patient medication adherence for chronic disease; 2, what countries do these published papers come from?; 3, what are the subject of the included studies within this systematic review by diseases are included in these papers?; 4, what study designs and research methodologies are applied in these studies; 5, what are the frequency and duration of delivered messages in these papers?; 6, were the studies' findings significant?; and 7, what are the sample sizes of participants in these papers?

2. Evidence Acquisition

We performed a systematic literature search in August 2013 using the following electronic bibliographic databases: PubMed, Embase, PsycINFO, CINAHL, and the Cochrane central register of controlled trials. We used the following Mesh terms and text words to search PubMed: (text message* OR short message service OR SMS OR cellular phone* OR portable cellular phone* OR mobile phone*) AND (medication adherence OR medication persistence OR medication compliance OR medication* OR drug OR prescript*)) PubMed search strategy, modified as needed for use in other databases. Moreover, additional studies have been identified by citation tracing, which was carried out at a later date. References were managed using Thomson ISI research Soft Endnote13. The initial evaluation was conducted on the basis of the title and the summary. When a study could not be included or rejected with certainty, the full text was examined in a second evaluation. Articles were separately evaluated by two experts, a telemedicine specialist (KB) and a health information management specialist (RE). Disagreements concerning the eligibility of evidence were resolved by a discussion between the two reviewers or by adjudication of a third reviewer. In the primary search, we found 69 articles related to the research topic, and then eight articles were added to them by citation tracing. After reviewing the full text of 77 articles and considering the inclusion and exclusion criteria, 43 studies were excluded because they did not meet the inclusion criteria; the final sample consisted of 34 articles. Figure 1 summarizes the steps taken to select relevant resources.

We included articles analyzing the use of text message reminders with the aim of improving medication adherence and focusing on chronic diseases. Moreover, studies were included if they were randomized and non-randomized controlled trials or, quasi-experimental studies and observational cohorts, pre-and post-test designs, non-experiment observational (cross-sectional, case-series, case study), and qualitative papers. Pilot studies were included, as they can provide a better understanding of the feasibility and acceptability of using text messages as medication reminders. Finally, we included studies from all countries in this review. Patients of any age who had been involved in an intervention using text messaging to improve their medication adherence were included in the study as well as studies in which SMS or text messaging interventions were delivered through a mobile phone as a reminder independent of other technologies. Moreover, we included studies in which the intervention was compared to no intervention, or to other interventions to promote medication adherence. Outcomes, including morbidity, mortality, hospitalization rates, clinical outcomes, adherence to medication, and patient satisfaction with an SMS reminder intervention, were considered. Studies were excluded if the interventions did not include the use of SMS/text messaging. We also excluded studies conducted via the internet, email, traditional landline telephones or other electronic devices, and medication alarms alone or in conjunction with mobile phone text messaging. Letters to the editor, editorials, and short communications were excluded as well. All papers used in our review were published in English. We also excluded studies if the abstract and full text of an article was not available or they were about acute and non-chronic diseases.

3. Results

A narrative summary of the selected studies was presented according to the details of the actual studies, such as design, subjects, location, and duration. The populations of the included studies in this review were described in terms of their sample size, mean age (years), frequency of messaging, description of intervention, and the type of adherence measures. A tabulation form was used to compare the results. The results and conclusions with $P < 0.05$ were considered significantly different (Appendix 1).

3.1. Study Designs

Twenty-two of the studies were RCTs (64.7%), one quasi-experimental (2.9%), two prospective (5.9%), two retrospective observational (5.9%), and four were cohort studies

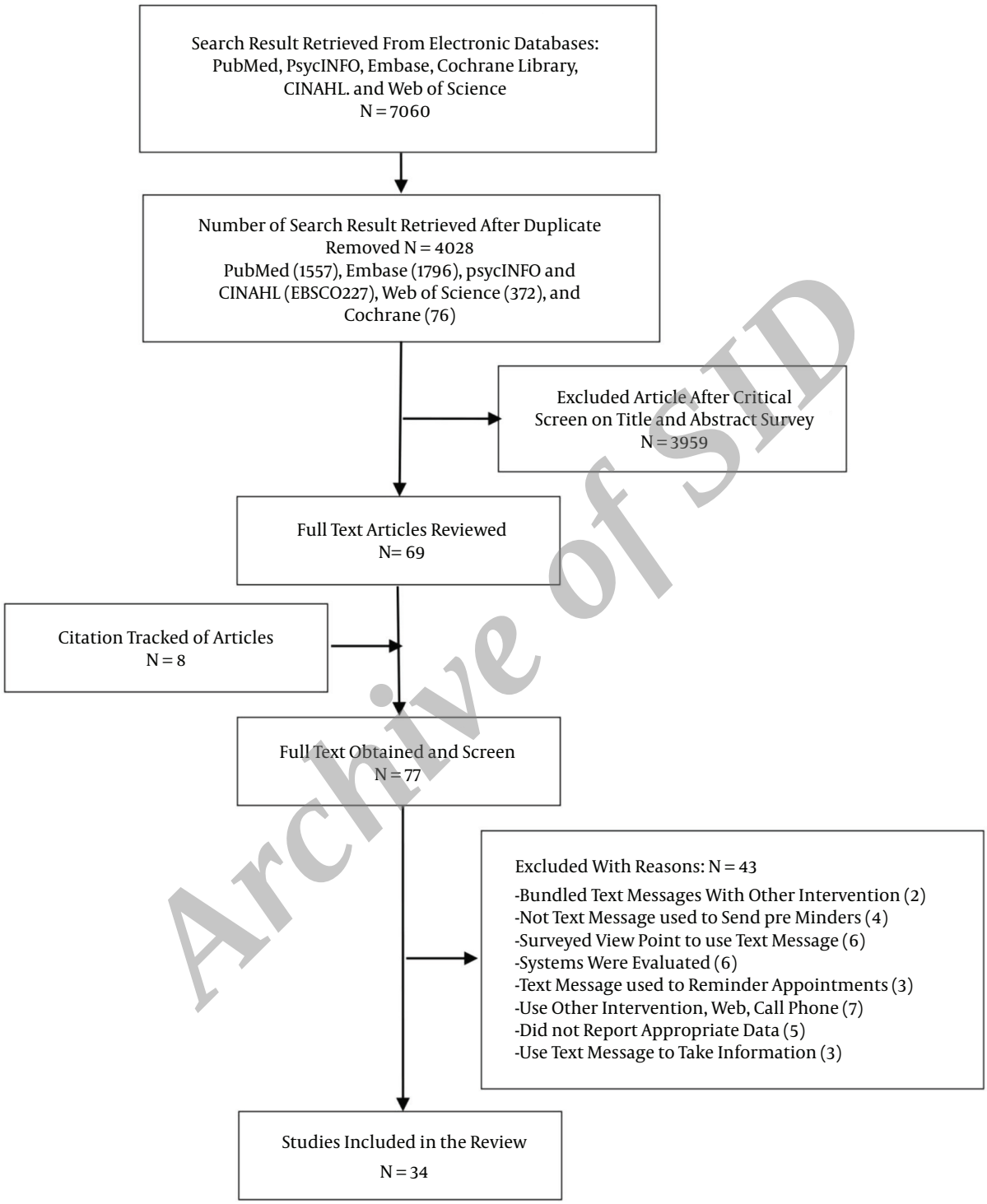

Figure 1. Flow Chart of the Study Selection Process

(11.8%). In addition, one qualitative study (2.9%), one real-time method (2.9%), and one proof-of-concept study (2.9%) were included; nine of 34 studies were pilot studies (26.5%).

3.2. Countries

The studies were mostly carried out in the United States (44%, n = 15), followed by the United Kingdom (8.8% n = 3), Spain (8.8% n = 3), China (5.8% n = 2), and the Netherlands (5.8% n = 2), while the rest of the studies (n = 9, 26.5%) were conducted in other countries (Taiwan, Singapore, Russia, Poland, Kenya, Iran, India, Ghana, Denmark; see Appendix 1.

3.3. Diseases

The range of diseases varies among the selected studies: antiretroviral (6 studies 17.1%), asthma (6 studies 17.1%), diabetes (5 studies 14.3%), heart (5 studies 14.3%), schizophrenia (4 studies 11.4%), tuberculosis (1 study 2.9%), dermatology problems (1 study 2.9%), lupus (1 study 2.9%), malaria (1 study 2.9%), general chronic diseases (2 studies 5.7%), allergies (1 study 2.9%), sickle cell anemia (1 study 2.9%), and anemia (1 study 2.9%) (Figure 2).

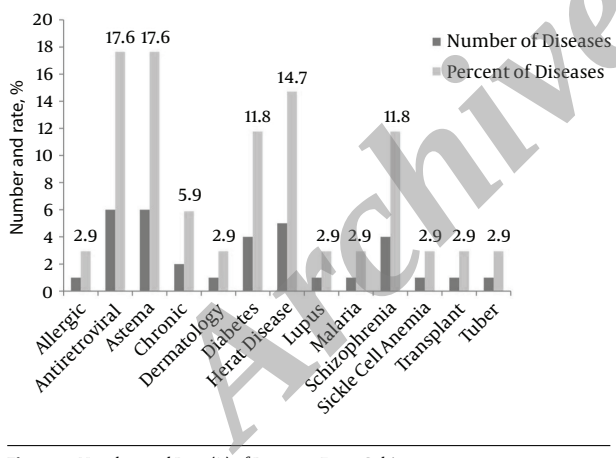

Figure 2. Number and Rate (%).of Paper on Every Subject

The most common groups were patients with antiretroviral and HIV diseases (n = 6, 17%) (24-29). These six studies showed strictly significant effects on patients' adherence. HIV needs to be studied in relation to the m-Health concept because the adherence of patients with HIV to antiretroviral medications is essential for both clinical effectiveness and public health. In three of six studies on asthma, subjects' improved compliance with texting reminders was demonstrated (1, 30, 31), while the results did not demonstrate a significant difference for the other three studies (P = 0.5) (32-34). These studies demonstrate that texting reminders can improve medication adherence in some asthmatic subjects (1, 30-34). Four studies evaluated the impact of SMS to management prescriptions and medication adherence in type 2 diabetes compared with standard care. These results showed that patients who received SMS had better clinical outcomes (P < 0.05) (35-39). Four studies examined the effects of text messaging on medication adherence in schizophrenic patients, and the results indicate the usefulness of text messaging for this group of diseases (P = 0.02, P = 0.03) (18, 40-42). Text messages were sent daily and seemed to be feasible, effective, and acceptable for enhancing medication adherence. Two studies highlighted the impact of mobile phone text messages on medication adherence in tuberculosis (TB) patients (P < 0.001) (43, 44). The results suggest that interactive SMS reminders are an acceptable and favorable method of supporting patients with TB in taking their medication.

Four of five (14.3%) studies on heart and hypertension patients have shown that text message reminders have been effective in patient medication adherence (P < 0.001) (19, 45-48). Weekly or daily intervention improved antihypertensive therapy and led to a significant decrease in patients' non-compliance and doubled the effectiveness of blood pressure control. Finally, one study examined diseases such as allergies, derma, Lupus, malaria, sickle cell, and transplants. All the above-mentioned studies, except one (23), have reported some benefits from sending reminders to patients (49-54).

3.4. Intervention Lengths

The intervention period of the included studies in this review varied from 1 week to 14 months, but the average intervention length was about four months (M = 4.7 months). The intervention length for non-significant studies was greater than average (14, 11, and 6 months and 2 weeks). Furthermore, the average number of participants was 211, ranging from 7 to 1198 (33, 55), Appendix 1.

3.5. Clinical Outcomes

Most of the studies reported the effectiveness of the intervention (88.2%) and only 14% of studies did not report statistically significant improvements in medication adherence in patients receiving reminder messages. Studies measuring the level of medication adherence in various ways, including self-report, pill counts, medical records, laboratory values, and pharmacy refills reported different monitoring systems, and among them self-report was the most commonly method used to measure medication adherence (41.2%), Appendix 1.

4. Conclusions

The findings of this systematic review indicate that there is a set of high-quality data on the effectiveness of SMS interventions for improving patients' adherence to medication. Our study differs from former studies since we decided to include studies using different research methods, while similar published reviews were limited to RCT studies. This could have limited the number of articles eligible for previous reviews and studies (56).

Previous studies were mostly carried out in the developed countries, particularly in the USA. These results are in accordance with pervious reviews reporting that recent research studies focused largely on the use of SMS for health purposes in developed countries, which were suggested to improve the use of mobile phone interventions to solve the challenges of their healthcare system, such as a limited healthcare workforce, limited financial resources, high burden of disease, high population growth, and difficulties in extending healthcare (56-59). Evidence reported the lack of a national e-health strategy, weak information communication technology (ICT) infrastructure, poor workers, and the lack of consumer literacy as obstacles to improved health in these countries (60). This review showed that mobile phone text-messaging is effective in promoting adherence to medications among different patient populations; these results are in accordance with previous systematic reviews, highlighting that interventions were efficacious in improving medication adherence in particular subjects (43, 61, 62). In these studies, a large number of interventions were focused on HIV/AIDS. This might be owing to this fact that patients play a key role in fighting against this virulent disease (58) and interventions such as mobile phone text-messaging have the potential to make a significant impact on the HIV epidemic (63). Furthermore, our review showed that SMS reminders were strongly effective in diabetes and hypertension. These results are in line with recent systematic reviews that have demonstrated evidence based on the use of text message reminders to improve medication adherence in these patients (19).

Three of six interventions on asthma patients revealed that their adherence rates when receiving daily SMS reminders were not higher than those of patients who were not reminded. Our results support other study findings focusing on asthma patients (1, 33, 34, 64, 65) and suggest that patients' characteristics and disease type influence their level of medication adherence; for instance, Huang (2013) remarked that older patients show resistance to behavioral change and are less familiar with cell phones than younger patients.

There is a body of evidence showing that SMS reminders sent once or more per day had a smaller effect and most patients preferred to receive two messages per week (37, 62, 63). Shetty (2011) noted that the relationship between increased frequency and decreased responses might have resulted from habituation, response fatigue, and the possible intrusion of multiple daily messaging (40). Mbuagbaw (2013) recommended the use of interactive weekly text messaging to improve adherence to ART, which is the most effective, Mbuagbaw (2013) also recommended the use of interactive weekly text messaging is the more effective to improve patient adherence to antiretroviral therapy (ART) (45, 66). According to the results of participants' satisfaction with the SMS intervention, the frequency of the SMS received the lowest satisfaction score of 3.1 points, while participants reported that "the frequency of text messages sent was too high," "text messages did not need to be sent often, and the number of messages was excessive (55). Further research is needed to consider the impact of the reminder frequency in improving medication adherence.

The most common time period for sending messages as reminders to patients was less than 6 months (8 days - 14 months, mean = 4 months). There is no significant relationship between the time period and patient adherence. Vervloet (2012) found the same results and reported all studies with the same findings, There was no significant relation between length of the text message reminder were sent to patients and their medication adherence. except two, which revealed significant general effects on medication adherence by reminders (15).

Various methods have been used to determine patient adherence to a medication regimen, but most studies used self-report as a measure of adherence. Self- report is a common and simple method to measure adherence; it can also differentiate between intentional and unintentional non-adherence (67), but overestimation of the level of adherence is the limitation of this method; hence, evidence has suggested using self-report combined with other methods of measuring adherence (68).

The strength of our study is the inclusion of a large number of studies, contrary to previous reviews, which have reported a limited number of studies. We included SMS interventions conducted using various methods other than RCTs, and we believe that synthesizing data from numerous studies would provide greater confidence in the effectiveness of these interventions (56, 69).

The limitation of our study is the exclusion of non-English language studies; thus, we might have missed some relevant data. In addition, we did not have evaluation and critical appraisals for the included studies in our review.

4.1. Recommendations

The results of the present systematic review suggested that there was very little or no literature available on the implementation of text message aiming to achieve medication adherence in some chronic diseases such as transplant, anemia, and multiple sclerosis. These findings highlight research gaps and offer many opportunities for further research studies.

We recommend further research focusing on a variety of diseases to better understand the effects of mobile technology and text messages, which are influenced by education level, gender, age, timing (weekly versus daily), and the disease severity. We also recommend that future studies be designed to include national databases in the literature review.

Supplements

Appendix 1 (including references 1, 6, 18, 19, 23-37, 39-42, 44-50 and 52-55) is available at below link: http://ircmj.com/?page=download&file_id=57882

Acknowledgments

This study is a part of a PhD dissertation financially supported by Iran University of Medical Sciences.

Footnotes

Authors' Contribution: All authors contributed equally to this work Farahnaz Sadoughi AND Roghayeh Ershad Sarabi designed the study and prepared the manuscript, Roghayeh Ershad Sarabi performed searches, Roghayeh Ershad Sarabi AND Kambiz Bahaadinbeigy independently reviewed the results and selected related articles, and Roohangiz Jamshidi Orak analysed and .reduced the data.

Conflict of Interest: The authors declare that there is no conflict of interests regarding the publishing of this paper.

References

1. Strandbygaard U, Thomsen SF, Backer V. A daily SMS reminder increases adherence to asthma treatment: a three-month follow-up study. *Respir Med.* 2010;**104**(2):166–71. doi: 10.1016/j.rmed.2009.10.003. [PubMed: 19854632].
2. Osterberg L, Blaschke T. Adherence to medication. *N Engl J Med.* 2005;**353**(5):487–97. doi: 10.1056/NEJMra050100. [PubMed: 16079372].
3. Sabate E. Adherence to long-term therapies: evidence for action. World Health Organization; 2003.
4. Braithwaite S, Shirkhorshidian I, Jones K, Johnsrud M. The role of medication adherence in the US healthcare system. Citeseer; 2013.
5. DiMatteo MR. Variations in patients' adherence to medical recommendations: a quantitative review of 50 years of research. *Med Care.* 2004;**42**(3):200–9. [PubMed: 15076819].
6. Foreman KF, Stockl KM, Le LB, Fisk E, Shah SM, Lew HC, et al. Impact of a text messaging pilot program on patient medication adherence. *Clin Ther.* 2012;**34**(5):1084–91. doi: 10.1016/j.clinthera.2012.04.007. [PubMed: 22554973].
7. Nilsson JL, Andersson K, Bergkvist A, Bjorkman I, Brismar A, Moen J. Refill adherence to repeat prescriptions of cancer drugs to ambulatory patients. *Eur J Cancer Care (Engl).* 2006;**15**(3):235–7. doi: 10.1111/j.1365-2354.2006.00645.x. [PubMed: 16882118].
8. Iman M, Saadabadi A, Davood A. Docking studies of phthalimide pharmacophore as a sodium channel blocker. *Iran J Basic Med Sci.* 2013;**16**(9):1016–21. [PubMed: 24171082].
9. Benjamin RM. Medication adherence: helping patients take their medicines as directed. *Public Health Rep.* 2012;**127**(1):2–3. [PubMed: 22298918].
10. Viswanathan M, Golin CE, Jones CD, Ashok M, Blalock SJ, Wines RC, et al. Interventions to improve adherence to self-administered medications for chronic diseases in the United States: a systematic review. *Ann Intern Med.* 2012;**157**(11):785–95. doi: 10.7326/0003-4819-157-11-201212040-00538. [PubMed: 22964778].
11. Brown MT, Bussell JK, editors. Medication adherence: WHO cares?. Mayo Clinic Proceedings. 2011; Elsevier; pp. 304–14.
12. Haynes RB, Ackloo E, Sahota N, McDonald HP, Yao X. Interventions for enhancing medication adherence. *Cochrane Database Syst Rev.* 2008(2):CD000011. doi: 10.1002/14651858.CD000011.pub3. [PubMed: 18425859].
13. Vollmer WM, Feldstein A, Smith DH, Dubanoski JP, Waterbury A, Schneider JL, et al. Use of health information technology to improve medication adherence. *Am J Manag Care.* 2011;**17**(12 Spec No.):SP79–87. [PubMed: 22216772].
14. Lowry KP, Dudley TK, Oddone EZ, Bosworth HB. Intentional and unintentional nonadherence to antihypertensive medication. *Ann Pharmacother.* 2005;**39**(7-8):1198–203. doi: 10.1345/aph.1E594. [PubMed: 15956238].
15. Vervloet M, Linn AJ, van Weert JC, de Bakker DH, Bouvy ML, van Dijk L. The effectiveness of interventions using electronic reminders to improve adherence to chronic medication: a systematic review of the literature. *J Am Med Inform Assoc.* 2012;**19**(5):696–704. doi: 10.1136/amiajnl-2011-000748. [PubMed: 22534082].
16. Wei J, Hollin I, Kachnowski S. A review of the use of mobile phone text messaging in clinical and healthy behaviour interventions. *J Telemed Telecare.* 2011;**17**(1):41–8. doi: 10.1258/jtt.2010.100322. [PubMed: 21097565].
17. Vodopivec-Jamsek V, de Jongh T, Gurol-Urganci I, Atun R, Car J. Mobile phone messaging for preventive health care. *Cochrane Database Syst Rev.* 2012;**12**.
18. Montes JM, Medina E, Gomez-Beneyto M, Maurino J. A short message service (SMS)-based strategy for enhancing adherence to antipsychotic medication in schizophrenia. *Psychiatry Res.* 2012;**200**(2-3):89–95. doi: 10.1016/j.psychres.2012.07.034. [PubMed: 22901437].
19. Park LG, Howie-Esquivel J, Chung ML, Dracup K. A text messaging intervention to promote medication adherence for patients with coronary heart disease: a randomized controlled trial. *Patient Educ Couns.* 2014;**94**(2):261–8. doi: 10.1016/j.pec.2013.10.027. [PubMed: 24321403].
20. Person AK, Blain ML, Jiang H, Rasmussen PW, Stout JE. Text messaging for enhancement of testing and treatment for tuberculosis, human immunodeficiency virus, and syphilis: a survey of attitudes toward cellular phones and healthcare. *Telemed J E Health.* 2011;**17**(3):189–95. doi: 10.1089/tmj.2010.0164. [PubMed: 21457085].
21. Rodrigues R, Shet A, Antony J, Sidney K, Arumugam K, Krishnamurthy S, et al. Supporting adherence to antiretroviral therapy with mobile phone reminders: results from a cohort in South India. *PLoS One.* 2012;**7**(8):ee40723. doi: 10.1371/journal.pone.0040723. [PubMed: 22952574].

22. Sidney K, Antony J, Rodrigues R, Arumugam K, Krishnamurthy S, D'Souza G, et al. Supporting patient adherence to antiretrovirals using mobile phone reminders: patient responses from South India. *AIDS Care.* 2012;**24**(5):612–7. doi: 10.1080/09540121.2011.630357. [PubMed: 22150088].
23. Ting TV, Kudalkar D, Nelson S, Cortina S, Pendl J, Budhani S, et al. Usefulness of cellular text messaging for improving adherence among adolescents and young adults with systemic lupus erythematosus. *J Rheumatol.* 2012;**39**(1):174–9. doi: 10.3899/jrheum.110771. [PubMed: 22089460].
24. da Costa TM, Barbosa BJ, Gomes e Costa DA, Sigulem D, de Fatima Marin H, Filho AC, et al. Results of a randomized controlled trial to assess the effects of a mobile SMS-based intervention on treatment adherence in HIV/AIDS-infected Brazilian women and impressions and satisfaction with respect to incoming messages. *Int J Med Inform.* 2012;**81**(4):257–69. doi: 10.1016/j.ijmedinf.2011.10.002. [PubMed: 22296762].
25. Dowshen N, Kuhns LM, Gray C, Lee S, Garofalo R. Feasibility of interactive text message response (ITR) as a novel, real-time measure of adherence to antiretroviral therapy for HIV+ youth. *AIDS Behav.* 2013;**17**(6):2237–43. doi: 10.1007/s10461-013-0464-6. [PubMed: 23546844].
26. Hardy H, Kumar V, Doros G, Farmer E, Drainoni ML, Rybin D, et al. Randomized controlled trial of a personalized cellular phone reminder system to enhance adherence to antiretroviral therapy. *AIDS Patient Care STDS.* 2011;**25**(3):153–61. doi: 10.1089/apc.2010.0006. [PubMed: 21323532].
27. Lester RT, Ritvo P, Mills EJ, Kariri A, Karanja S, Chung MH, et al. Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): a randomised trial. *The Lancet.* 2010;**376**(9755):1838–45.
28. Lewis MA, Uhrig JD, Bann CM, Harris JL, Furberg RD, Coomes C, et al. Tailored text messaging intervention for HIV adherence: a proof-of-concept study. *Health Psychol.* 2013;**32**(3):248–53. doi: 10.1037/a0028109. [PubMed: 22545972].
29. Pop-Eleches C, Thirumurthy H, Habyarimana JP, Zivin JG, Goldstein MP, De Walque D, et al. Mobile phone technologies improve adherence to antiretroviral treatment in a resource-limited setting: a randomized controlled trial of text message reminders. *AIDS.* 2011;**25**(6):825.
30. Searing DA, Bender BG. Short Message Service (SMS) For Asthma Management: A Pilot Study Utilizing Text Messaging To Promote Asthma Self-management. *J Allergy Clin Immunol.* 2012;**129**(2):AB142. doi: 10.1016/j.jaci.2011.12.477.
31. Lv Y, Zhao H, Liang Z, Dong H, Liu L, Zhang D, et al. A mobile phone short message service improves perceived control of asthma: a randomized controlled trial. *Telemed J E Health.* 2012;**18**(6):420–6. doi: 10.1089/tmj.2011.0218. [PubMed: 22667695].
32. Britto MT, Munafo JK, Schoettker PJ, Vockell AL, Wimberg JA, Yi MS. Pilot and feasibility test of adolescent-controlled text messaging reminders. *Clin Pediatr (Phila).* 2012;**51**(2):114–21. doi: 10.1177/0009922811412950. [PubMed: 22019792].
33. Lee JS, Safier B, Ballow M, editors. Ann Allergy Asthma Immunol. 2011; New York. Elsevier Science Inc; p. A37.
34. Prabhakaran L, Chee WY, Chua K, Abisheganaden J, Wong W. The use of text messaging to improve asthma control: a pilot study using the mobile phone short messaging service (SMS). *J Telemed Telecare.* 2010;**16**(5):286–90.
35. Vervloet M, van Dijk L, Santen-Reestman J, van Vlijmen B, van Wingerden P, Bouvy ML, et al. SMS reminders improve adherence to oral medication in type 2 diabetes patients who are real time electronically monitored. *Int J Med Inform.* 2012;**81**(9):594–604. doi: 10.1016/j.ijmedinf.2012.05.005. [PubMed: 22652012].
36. Zolfaghari M, Mousavifar SA, Pedram S, Haghani H. The impact of nurse short message services and telephone follow-ups on diabetic adherence: which one is more effective?. *J Clin Nurs.* 2012;**21**(13-14):1922–31. doi: 10.1111/j.1365-2702.2011.03951.x. [PubMed: 22239205].
37. Shetty AS, Chamukuttan S, Nanditha A, Raj RK, Ramachandran A. Reinforcement of adherence to prescription recommendations in Asian Indian diabetes patients using short message service (SMS)–a pilot study. *J Assoc Physicians India.* 2011;**59**:711–4. [PubMed: 22616337].
38. Hanauer DA, Wentzell K, Laffel N, Laffel LM. Computerized Automated Reminder Diabetes System (CARDS): e-mail and SMS cell phone text messaging reminders to support diabetes management. *Diabetes Technol Ther.* 2009;**11**(2):99–106.
39. Arora S, Peters AL, Burner E, Lam C, Menchine M. Trial to examine text message–based mHealth in emergency department patients with diabetes (TExT-MED): A randomized controlled trial. *Ann Emerg Med.* 2014;**63**(6):745–54.
40. Van Gent E, Der Klein V, Knoppert E, editors. Improving compliance and treatment outcome in bipolar and schizophrenic patients by using Short Message Text Service (SMS). International Journal of Psychiatry in Clinical Practice. 2010; England. Informa Healthcare Telephone House; p. 39.
41. Granholm E, Ben-Zeev D, Link PC, Bradshaw KR, Holden JL. Mobile Assessment and Treatment for Schizophrenia (MATS): a pilot trial of an interactive text-messaging intervention for medication adherence, socialization, and auditory hallucinations. *Schizophr Bull.* 2012;**38**(3):414–25. doi: 10.1093/schbul/sbr155. [PubMed: 22080492].
42. Maurino J, Tesoro A, Díez T, Gomez-Beneyto M. AD1 SHORT MESSAGE SERVICE (SMS)-BASED STRATEGY TO IMPROVE ANTIPSYCHOTIC ADHERENCE AMONG PATIENTS WITH SCHIZOPHRENIA. *Value in Health.* 2010;**13**(7):eA242. .
43. Nglazi MD, Bekker LG, Wood R, Hussey GD, Wiysonge CS. Mobile phone text messaging for promoting adherence to anti-tuberculosis treatment: a systematic review. *BMC Infect Dis.* 2013;**13**:566. doi: 10.1186/1471-2334-13-566. [PubMed: 24295439].
44. Mohammed S, Siddiqi O, Ali O, Habib A, Haqqi F, Kausar M, et al. User engagement with and attitudes towards an interactive SMS reminder system for patients with tuberculosis. *J Telemed Telecare.* 2012;**18**(7):404–8. doi: 10.1258/jtt.2012.120311. [PubMed: 23034935].
45. Wizner B, Gaciong Z, Narkiewicz K, Grodzicki T. Education using SMS increases efficacy of treatment of hypertensive patients. *Nadcisnienie Tetnicze.* 2009;**13**(3):147–57.
46. Raiman L, Wald D, Bestwick J. Interact investigation of text message reminders on adherence to cardiac treatment-pilot study. *Circulation.* 2013;**127**(12 Supplement):AMP38.
47. Marquez CE, de la Figuera M, Gil GV, Ylla-Catala A, Figueras M, Balana M, et al. Effectiveness of an intervention to provide information to patients with hypertension as short text messages and reminders sent to their mobile phone (HTA-Alert. *Atencion primaria.* 2004;**34**(8):399–405.
48. Kiselev AR, Gridnev VI, Shvartz VA, Posnenkova OM, Dovgalevsky PY. Active ambulatory care management supported by short message services and mobile phone technology in patients with arterial hypertension. *J Am Soc Hypertens.* 2012;**6**(5):346–55. doi: 10.1016/j.jash.2012.08.001. [PubMed: 22995803].
49. Wang K, Wang C, Xi L, Zhang Y, Ouyang Y, Lou H, et al. A randomized controlled trial to assess adherence to allergic rhinitis treatment following a daily short message service (SMS) via the mobile phone. *Int Arch Allergy Immunol.* 2014;**163**(1):51–8. doi: 10.1159/000356317. [PubMed: 24248037].
50. Pena-Robichaux V, Kvedar JC, Watson AJ. Text messages as a reminder aid and educational tool in adults and adolescents with atopic dermatitis: a pilot study. *Dermatol Res Pract.* 2010;**163**(1):51–8.
51. Armstrong AW, Watson AJ, Makredes M, Frangos JE, Kimball AB, Kvedar JC. Text-message reminders to improve sunscreen use: a randomized, controlled trial using electronic monitoring. *Arch Dermatol.* 2009;**145**(11):1230–6.
52. Estepp J, Johnson M, Smeltzer M, Winter B, Carroll Y, Hankins J, editors. Improved Adherence To Hydroxyurea In Children With Sickle

Cell Anemia Utilizing Text Messages. Pediatric Blood and Cancer. 2013; USA. Wiley-blackwell; p. S23.
53. Goldberg J, Fink G. A randomized trial of text message reminders to increase adherence to malaria treatmen. *American Journal of Tropical Medicine and Hygiene*. 2012;**87**(5):107.
54. Miloh T, Arnon R, Warshaw J, Kerkar N, Iyer K. Text messaging significantly improves adherence to immunosuppressants in pediatric liver transplant recipients. *Pediatric Transplantation*. 2009;**13**:62–3.
55. Huang HL, Li YC, Chou YC, Hsieh YW, Kuo F, Tsai WC, et al. Effects of and satisfaction with short message service reminders for patient medication adherence: a randomized controlled study. *BMC Med Inform Decis Mak*. 2013;**13**:127. doi: 10.1186/1472-6947-13-127. [PubMed: 24238397].
56. Beratarrechea A, Lee AG, Willner JM, Jahangir E, Ciapponi A, Rubinstein A. The impact of mobile health interventions on chronic disease outcomes in developing countries: a systematic review. *Telemed J E Health*. 2014;**20**(1):75–82. doi: 10.1089/tmj.2012.0328. [PubMed: 24205809].
57. Deglise C, Suggs LS, Odermatt P. Short message service (SMS) applications for disease prevention in developing countries. *J Med Internet Res*. 2012;**14**(1):ee3. doi: 10.2196/jmir.1823. [PubMed: 22262730].
58. Deglise C, Suggs LS, Odermatt P. SMS for disease control in developing countries: a systematic review of mobile health applications. *J Telemed Telecare*. 2012;**18**(5):273–81. doi: 10.1258/jtt.2012.110810. [PubMed: 22826375].
59. Cole-Lewis H, Kershaw T. Text messaging as a tool for behavior change in disease prevention and management. *Epidemiol Rev*. 2010;**32**:56–69. doi: 10.1093/epirev/mxq004. [PubMed: 20354039].
60. Qiang C, Yamamichi M, Hausman V, Altman D, Unit I. Mobile applications for the health sector. 2011.
61. Herbert L, Owen V, Pascarella L, Streisand R. Text message interventions for children and adolescents with type 1 diabetes: a systematic review. *Diabetes Technol Ther*. 2013;**15**(5):362–70. doi: 10.1089/dia.2012.0291. [PubMed: 23550554].
62. Finitsis DJ, Pellowski JA, Johnson BT. Text message intervention designs to promote adherence to antiretroviral therapy (ART): a meta-analysis of randomized controlled trials. *PLoS One*. 2014;**9**(2):ee88166. doi: 10.1371/journal.pone.0088166. [PubMed: 24505411].
63. Horvath T, Azman H, Kennedy GE, Rutherford GW. Mobile phone text messaging for promoting adherence to antiretroviral therapy in patients with HIV infection. *Cochrane Database Syst Rev*. 2012;**3**:CD009756. doi: 10.1002/14651858.CD009756. [PubMed: 22419345].
64. Nickels A, Dimov V. Innovations in technology: social media and mobile technology in the care of adolescents with asthma. *Curr Allergy Asthma Rep*. 2012;**12**(6):607–12. doi: 10.1007/s11882-012-0299-7. [PubMed: 22976493].
65. Tran N, Coffman JM, Sumino K, Cabana MD. Patient reminder systems and asthma medication adherence: a systematic review. *J Asthma*. 2014;**51**(5):536–43. doi: 10.3109/02770903.2014.888572. [PubMed: 24506699].
66. Mbuagbaw L, van der Kop ML, Lester RT, Thirumurthy H, Pop-Eleches C, Ye C, et al. Mobile phone text messages for improving adherence to antiretroviral therapy (ART): an individual patient data meta-analysis of randomised trials. *BMJ Open*. 2013;**3**(12):e003950. doi: 10.1136/bmjopen-2013-003950. [PubMed: 24345901].
67. Garfield S, Clifford S, Eliasson L, Barber N, Willson A. Suitability of measures of self-reported medication adherence for routine clinical use: a systematic review. *BMC Med Res Methodol*. 2011;**11**:149. doi: 10.1186/1471-2288-11-149. [PubMed: 22050830].
68. Smith SR, Wahed AS, Kelley SS, Conjeevaram HS, Robuck PR, Fried MW, et al. Assessing the validity of self-reported medication adherence in hepatitis C treatment. *Ann Pharmacother*. 2007;**41**(7):1116–23. doi: 10.1345/aph.1K024. [PubMed: 17519299].
69. Lunny C, Taylor D, Memetovic J, Warje O, Lester R, Wong T, et al. Short message service (SMS) interventions for the prevention and treatment of sexually transmitted infections: a systematic review protocol. *Syst Rev*. 2014;**3**:7. doi: 10.1186/2046-4053-3-7. [PubMed: 24433348].