Text Messaging as a Simple Strategy to Improve Medication Adherence in Hypertensive Patients: A Step in Decreasing Stroke

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Summer 2020

Abstract

Hypertension remains a prevalent public health concern mainly because adherence to antihypertensive medications is suboptimal. Traditional interventions to improve adherence are complex and not widely effective. The focus of this study is to explore the effect of text messaging as a simple strategy to reduce nonadherence in hypertensive patients as a step in decreasing incidence of stroke. Text messaging is chosen only to address a barrier at the patient level such as the lack of recall or forgetting. Therefore the question is: What is the relationship between text messaging and the reduction of medication nonadherence among hypertensive patients? A critical review of the literature was done. Literature search was conducted on CINAHL, Medline, PubMed, and Google Scholar, as well as reference lists of the articles identified. Eligible studies had to contain text messaging with the outcome of improved medication adherence in adults 18 years or older with hypertension. The Health Belief Model with illustration was chosen for theoretical framework of the paper. Ten studies were selected (5 RCTs, 3 meta-analyses, 2 systematic reviews). Only 3 studies focused specifically on hypertension, as there were limited studies done on adherence in hypertensive patients. All 10 studies concluded that text message reminders improve medication adherence among patients with chronic disease, although some results are not statistically significant. In conclusion, text messaging can improve medication adherence to antihypertensive medications. While the results are promising, more research is needed given the short duration of the studies and reliance on self-reported measure such as Morisky medication adherence scale for medication adherence.

Keywords: text messaging, medication nonadherence, hypertension, Morisky medication adherence scale

Table of Contents

Chapter 1

Introduction and Background

Hypertension remains a major public health concern in the United States with one third (almost 78 million) of adult Americans 20 years and older suffering from the condition (Buis et al., 2015; Choudry et al., 2018) costing an estimated $51.2 billion in 2012 to 2013 (Zhang & Moran, 2017). It is defined as systolic BP ≥ 130 mmHg or diastolic BP ≥ 80 mmHg based on average of two or more measurements at two or more clinic visits (Andre et al., 2019; Khan et al., 2017). Hypertension is the leading independent risk factor for stroke, congestive heart failure, and renal failure which are also considered complications of hypertension (Andre et al., 2019; Choudry et al., 2018). Hypertensive patients have a 63% lifetime risk of cardiovascular disease as a complication at 30 years of age compared with 46% for those with normal blood pressure (Varleta et al., 2017). The World Health Organization (WHO) stated that more than half (54%) of the 56.9 million deaths worldwide in 2016 were due to the top 10 causes, with ischemic heart disease and stroke as the number one and number two biggest killers, respectively, that have remained the leading causes of death globally in the last 15 years (Lee et al., 2017; WHO, 2018). Antihypertensive drugs are effective in preventing complications of stroke and death related to hypertension. Numerous guidelines have been issued by the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure during the past years for the optimal therapy of hypertension with different classes of drugs. Hernandez (2015) provided a review of the latest guideline (JNC 8) for treatment of hypertension. But blood pressure (BP) control remains poor even in developed countries, which negatively impacts the prevention of complications (Hamdidouche et al., 2017; Varleta et al., 2017).

Medication nonadherence in hypertension. Medication nonadherence is the leading and the most important cause of uncontrolled BP, which may prove to be the greatest barrier to the effectiveness of antihypertensive therapy, and is becoming a rising issue in the management of hypertension (Abegaz et al., 2017; Andre et al., 2019; Davidson et al., 2015; Hamdidouche et al., 2017). In fact, only 50% of all hypertensive patients are considered adherent to prescribed medications (primary prevention) and about one third of patients do not adhere to treatment following a stroke (secondary prevention) (Buis et al., 2017; Choudry et al., 2018; Roldan et al., 2018; Wald et al., 2014). A systematic review of 28 studies from 15 countries by Abegaz et al. (2017) found 45.2% of the hypertensive patients and 31.2% of the hypertensive patients with comorbidities were nonadherent to medications, and that nearly two-thirds (62.5%) of medication nonadherence was noticed in Africans and Asians. Thakkar et al. (2016) stated that nonadherence is worse in lower socioeconomic groups and in developing countries.

Medication adherence is defined as the extent to which a patient follows the prescribed dose, frequency, and timing of a medication (Andre et al., 2019; Davidson et al, 2015; Hamdidouche et al., 2017). Medication nonadherence is taking <80% of prescribed doses (Conway & Kelechi, 2017; Strandbygaard et al., 2010). Among the many reasons for medication nonadherence, forgetting to take a medication is the most common (Buis et al., 2015; Chaudhri et al., 2019). Other causes of nonadherence include patients' lack of education about importance of taking medicines and health benefits by taking them, drug side effects, complicated drug therapy, and running out of prescription which might be related to forgetfulness. Nonadherence has been linked to hospital readmissions and increased need for medical interventions as well as increased morbidity and mortality. Medication nonadherence has been associated with 125,000 deaths, 10% of hospitalizations, and costs to the U. S. healthcare system up $100-289 billion annually

(Thakkar et al., 2016). Lee et al. (2017) concluded in their retrospective cohort study that medication nonadherence in hypertensive patients was associated with an increased risk of stroke.

Health Belief Model. The Health Belief Model is one of the first and most widely recognized theories of health behavior developed in the 1950s, which later expanded and concluded that "six main constructs influence people's decisions about whether to take action to prevent, screen for, and control illness," and these are perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cue to action, and self-efficacy (Butts & Rich, 2015). Asymptomatic patients, such as most hypertensive patients, may have problem with medication adherence if they do not believe they actually have hypertension (perceived susceptibility). They tend to not take their medications if they do not understand that hypertension can lead to stroke (perceived severity) or that taking medication will reduce the risk of stroke (perceived benefit), or if they are concerned about major side effects (perceived barriers). Patients need to have confidence in themselves to be able to follow their doctors' recommendations (self-efficacy). To encourage patients to follow a prescribed treatment regimen especially for patients who tend to forget, reminders such as text messaging may be used (cue to action).

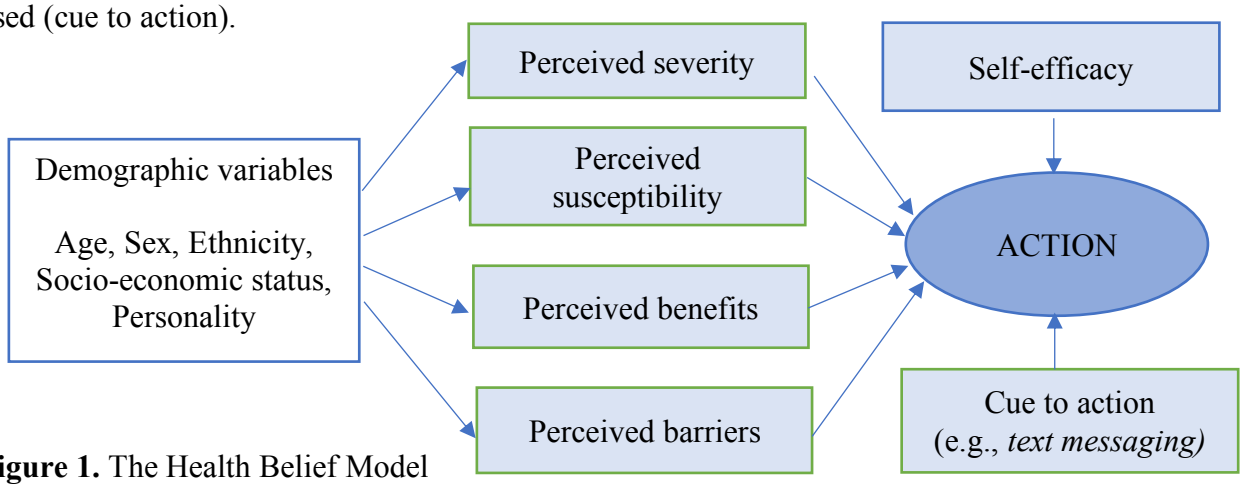


Figure 1. The Health Belief Model

Mobile health. Traditional interventions to improve adherence are complex and not widely effective. There is widespread need for convenient and feasible innovations to help patients remain adherent to medications, and mobile telephone text messaging maybe a scalable means to support medication adherence (Thakkar et al., 2016). Text messaging is a popular form of communication around the world. The Pew Research Center Internet and Technology (2018) stated that 96% of American adults own cell phones and three-quarters of users (73%) send and receive text messages. Text messaging has also been considered part of the larger strategy of mobile health (mHealth) which is an innovative and emerging field in preventive medicine and chronic disease management, and it has been recommended for use in various healthcare fields (Schwebel & Larimer, 2018). The Global Observatory for eHealth (GOe) defined mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" (WHO, 2011, p. 6).

Purpose statement. Thakkar et al. (2016) noted that nonadherence to long-term therapies in chronic disease has been extensively researched, but the rates of nonadherence have not changed. Since there have been limited studies to estimate the effect of text messaging in medication adherence of hypertensive patients, the focus of this paper is to explore the effect of text messaging as a simple strategy to reduce nonadherence in hypertensive patients as a step in decreasing incidence of stroke. Although there are multiple barriers to medication adherence, text messaging is chosen only to address a barrier at the patient level such as the lack of recall or forgetting. Therefore the purpose of the study is to answer the question: What is the relationship between text messaging and the reduction of medication nonadherence among hypertensive patients?

Chapter 2

Methods

Data sources and search strategy. Literature search was done from CINAHL, Medline, and PubMed. MeSH terms: text messaging OR SMS messaging OR reminder AND hypertension or chronic disease AND medication or adherence. Google scholar was searched to find any unpublished reviews, and reference lists of relevant reviews were searched to identify any additional reviews not captured by the selected database searches. A total of 256 articles were found.

Inclusion criteria and exclusion criteria. The search was limited to studies published in English between 2010 and 2019. Included articles must have evaluated text messaging sent to patients' mobile phones designed to promote adherence, either as stand-alone programs or combined with other intervention such as education. Participants are adult patients ≥18 years with hypertension or another chronic disease who were taking prescribed medications. Randomized control trials, systematic reviews, and meta-analysis were included . Studies that used health communication modalities other than text messaging, such as mobile apps, interactive video recording or emails were excluded, and studies on patients with psychiatric problems are excluded due to psychosocial reasons that may potentially influence adherence. A final set of 10 articles were selected based on the inclusion criteria (5 RCTs, 3 meta-analyses, 2 systematic reviews).

Chapter 3

Literature Review

Text messaging has become a focus of researchers as a tool in improving medication adherence in chronic diseases mainly as reminders and as behavior change interventions (Sarabi

et al., 2016; Schwebel & Larimer, 2018). To determine whether text messaging can improve medication adherence among hypertensive patients, literature search was done and a total of 10 studies were selected, organized, and analyzed. Out of the 10 studies selected, only 3 studies (2 RCTs and 1 systematic review) included hypertension, while the rest focused on stroke, asthma, HIV or chronic disease in general. The duration of the studies ranged from 8 weeks to 1 year, with samples ranging from 26 to 314, and most participants are females. Even if other chronic diseases are included along with hypertension, and the duration of the studies differ, Thakkar et al. (2016) in a meta-analysis of 16 RCTs found that the effect of text messaging on medication adherence was not sensitive to type of disease or duration of intervention.

Overall, the 10 studies have concluded that text message reminders can improve medication adherence among patients with hypertension and other chronic diseases, although some results are not statistically significant. A meta-analysis by Thakkar et al. (2016) found that text messaging significantly improved medication adherence in chronic disease such as hypertension, HIV, acute coronary syndrome, asthma, and diabetes (odds ratio, 2.11; 95% CI, 1.52-2.93; $P < .001$). Head et al. (2013) reviewed 19 RCTs regarding efficacy of text-messaging-based interventions for health promotion and found that the overall weighted mean effect size representing the impact of these interventions on health outcomes (including compliance with malaria chemoprophylaxis) was $d = .329$ (95% CI = .274, .385; $p < .001$). This effect size was statistically heterogeneous ($Q_{18} = 55.60$, $p < .001$, $I^2 = 67.62$), and several variables significantly moderated the effects of interventions. A review of 7 articles (5 clinical trials and 2 systematic reviews) by Andre et al. (2019) found that nonadherent patients with hypertension benefit more from mobile phone-based intervention than adherent patients at baseline: RR 2.3 (95% CI: 1.4-4.4, $p<0.001$ vs RR 1.3 (95% CI: 1.0-1.6, $p<0.05$), and that the reduction of blood pressure in

participants who were given reminder through mobile phones was greater in comparison to control: systolic (94.4% vs 41.2%, p=0.003), diastolic (94.4% vs 76.5%, p=0.04). A study by Varleta et al. (2017) found that medication adherence in hypertensive patients who received text messaging increased from 49% to 62.3% (p=0.1), RR 1.3%; 95% CI:1.0-1.6, p<0.05).

A study by Buis et al. (2015) showed increased medication adherence among randomized patients with hypertension although not statistically significant due to relatively small sample sizes and short-term follow-up period (mean change 0.9, SD 2.0 vs mean change 0.5, SD 1.5, p=0.26). Buis et al. (2015) also mentioned Hawthorne effect because the control group knew they were in a study about medication adherence. Nevertheless, patterns of improvement in the intervention group suggest that text messaging may have an effect, and larger RCTs of text messaging with longer duration are needed. The other study that did not find conclusive evidence of improved medication adherence is an integrative review by Conway & Kelechi (2017), for the same reasons of short duration of study and small sample, as well as a variety of interventions used (e.g., SMS text messaging, interactive voice response [IVR], telemonitoring).

Since there are limited studies targeting patients with hypertension that meet the criteria, a study on patients with asthma, HIV, stroke, and coronary heart disease that met the criteria were included for comparison, all with significant findings. A study by Strandbygaard et al. (2010) on patients with asthma showed the difference in mean adherence rate of 17.8%, 95% CI (3.2-32.3%), p=0.019 between those that received daily text messages and those that did not. A study by Finitsis et al. (2014) on text messaging to promote adherence to antiretroviral therapy in HIV patients found significantly higher adherence in the intervention group than control conditions (OR=1.39; 95% CI=1.18, 1.64). A study by Kamal et al. (2015) on adult stroke patients found that after 2 months of short messaging service reminders, the mean medication score was 7.4

(95 % CI: 7.2–7.6) in the intervention group while 6.7 (95 % CI: 6.4–7.02) in the control group. The adjusted mean difference was statistically significant 0.54 (95 % CI: 0.22–0.85), $p<0.01$. The relative cognitive impairment of stroke patients did not seem to affect the text messaging intervention, and the patients actually became compliant. A study by Khonsari et al. (2015) on patients with acute coronary syndrome after being discharged from the hospital found that there was a higher medication adherence level in the intervention group than the usual care group, (χ^2 (2)=18.614, $p<0.001$).

There was considerable variation in the types of text message intervention used to improve medication adherence. Two studies utilized automated one-way short text-message reminder daily before medication intake (Khonsari et al., 2015; Strandbygaard et al., 2010). One study used an automated text message system called BPMED that sends daily medication reminders to patients at individually customized times (Buis et al., 2017). Another study added education in their daily text message intervention such as importance of medication intake and adherence and healthy diet (Varleta et al., 2017). Another study used a two-way automated SMS reminders customized to the patient's prescription which required participants to respond to the SMS stating if they have taken their medicines which also included twice weekly customized health information (Kamal et al., 2015). One study sent different text messages every 12 ±2 days and limited to 160 characters, and only the first message reminded patients to take their medication while the rest of the text messages provided simple education regarding management of hypertension such as diet and medication (Varleta et al., 2017) (see Appendices A and B). Another method of mobile phone intervention involved an external BP monitoring device (Andre et al., 2019).

Mixed results were found regarding effects of different text message intervention characteristics on medication adherence. Head et al. (2013) found that personalization or message tailoring and decreasing frequency of messages instead of fixed frequency were significantly associated with greater intervention efficacy, although no significant differences were found between text-only interventions and interventions that included texting plus other components. Similarly, in a meta-analysis of text messaging on HIV patients, Finitsis et al. (2014) found that studies had larger effects when interventions were sent less frequently than daily, supported bidirectional communication, included personalized message content, and were matched to participants' therapy dosing schedule. Finitsis et al. (2014) stated that the smaller effects of text messaging once daily or more times daily in HIV patients may have resulted from response fatigue, habituation, and possible intrusion from multiple daily messaging based on multiple daily doses of antiretroviral therapy. Finitsis et al. (2014) also stated that better outcomes of bidirectional or two-way messaging maybe due to enhanced engagement or increasing trust, and that personalized message may have produced less intrusive content. Khonsari et al. (2015) stated that it is the simple, practical, and easy-to-use type of text messaging that holds the most promising intervention that optimizes medication adherence. However, Thakkar et al. (2016) found that the effect on medication adherence was not sensitive to text message characteristics such as daily or less frequent text message, as well as personalization or customization, and one way or two-way communication.

The outcome of this study is medication adherence which can be measured by a variety of parameters such as self-recall with Morisky Medication Adherence Scale (MMAS) (see Appendix C), electronic drug monitoring, pill count, pharmacy refill rates, the timing of the opening of a drug container lid (with embedded microchip), and biological outcomes (e. g., BP

measurements, CD4). Most of the selected studies used the Morisky adherence questionnaire. One study used Morisky-Green-Levine questionnaire which is an older version of MMAS (see Appendix D). A study of asthma patients used medication administration count on the inhaler device as a measure of adherence (Strandbygaard et al., 2010). Kamal et al. (2015) stated that there are no ideal measures for reporting medication adherence and that the MMAS is considered reliable as it corresponds well to pharmacy refill rates.

Regarding validity of Morisky Medication Adherence scale, the selected studies offer conflicting views. Buis et al. (2015) stated that since MMAS is a self-reported measure, it is not an objective assessment which can suffer from overestimation of medication adherence, and that instrumented pill bottles, caps, or biomarkers may provide better approximations of adherence. In contrast, Khonsari et al. (2015) used MMAS in their study of text messaging in improving medication adherence among patients with acute coronary syndrome and they claimed that MMAS is a well-validated self-report questionnaire with good predictive validity to assess medication-taking behavior and adherence. Also, Kamal et al. (2015) used the Urdu version of MMAS which has been validated with a sensitivity of 46% and specificity of 60%.

With regards to feasibility and acceptance of text messaging as intervention, Buis et al. (2015), Kamal et al. (2015), and Thakkar et al. (2016) found that participants of their studies were very satisfied with and enthusiastic about the program using text messaging.

In summary, most of the studies are of short duration and the evidence supporting short-term efficacy has been mixed. There is a gap in literature regarding evidence supporting long-term efficacy of text message medication reminders. In addition, little work has been done to study text messaging reminders within the context of HTN, although several studies have

investigated its use for a variety of chronic diseases, conditions, therapeutic regimens, and health promotion. Moreover, little has been mentioned regarding how much of medication adherence is enough to be considered significant. Lastly, only a few of the studies had a theoretical basis of their study and, therefore, there is a question how features of text messaging can be integrated with health behavior change theories.

Chapter 4

Conclusion

The research findings for the use of text messaging in health care are very promising, and text messaging is found effective in improving medication adherence in hypertensive patients. It is unclear what characteristics of text messaging is most effective regarding timing, frequency, and interactivity of text messaging, as well as total number of messages or duration of intervention. Nevertheless, the studies provide moderate quality evidence that text messaging reminders may indeed have some positive impacts on medication adherence and health status of hypertensive patients. Given the increasing prevalence of hypertension and its serious consequences, and the high burden of uncontrolled hypertension worldwide, as well as the difficulty of making regular visits to primary care clinics to be educated and monitored, the methods of text messaging could be considered as an inexpensive, easy to use, and instantaneous intervention that can be implemented in primary care clinics across the U.S and worldwide. However, the strength of the evidence is limited due to the small number and size of studies included. More research needs to be done with larger samples, longer duration, and more objective measurement of medication adherence so that the intervention of text messaging maybe developed further before being applied in nursing practice.

Pilot Study

To test the viability of this study for Hawaii populations, a pilot study to determine whether text messaging as a reminder can improve medication adherence among hypertensive patients, will be done at WCCHC. Twenty participants will be recruited from primary clinics in Waianae, based on the following criteria: Filipino and/or Asian and/or Hawaiian, aged ≥18 years, reads and understands English, diagnosed with HTN based on ICD-10 codes in the medical record within 1 year, taking one antihypertensive medication, does not have any other chronic illnesses, owns a mobile phone capable of receiving text messages, and able to pay for and obtain medications. Institutional Review Board (IRB) approval will be obtained from both Hawaii Pacific University Research Committee and WCCHC IRB. Those eligible will be consented, enrolled, and randomized into intervention and control groups, followed by baseline data collection. Participant data will be collected again at one-month follow-up. Text messaging will be one-way tailored and individualized messaging, sent daily at the same time of patients' medication doses to remind the patients to take their medications. For example, "Jane, take 1 tablet of Amlodipine at 9:00 a.m." The outcome of the pilot study is antihypertensive therapy adherence; BP control is not an outcome measured during the study. Participants will complete self-reported assessments in paper format using the Morisky Medication Adherence Scale (MMAS) at baseline and one month. Descriptive statistics will be used to describe participant characteristics. Chi-Square test will be used for comparison. The non-parametric Mann Whitney U test will be used to compare the values of MMAS scores at baseline and 1 month for both groups.

References

Abegaz, T. M., Shehab, A., Gebreyohannes, E. A., Bhagavathula, A. S., & Elnour, A. A. (2017). Nonadherence to antihypertensive drugs: A systematic review and meta-analysis. *Medicine, 96*(4):e5641. https://doi:10.1097/MD.0000000000005641

Andre, N., Wibawanti, R., & Siswanto, B. B. (2019). Mobile phone-based intervention in hypertension management. *International Journal of Hypertension, 2019*. https://doi.org/10.1155/2019/9021017

Buis, L., Hirzel, L., Dawood, R. M., Dawood, K. L., Nichols, L. P., Artinian, N. T.,…Levy, P. D. (2017). Text messaging to improve hypertension medication adherence in African Americans from primary care and emergency department settings: Results from two randomized feasibility studies. *JMIR mHealth and uHealth, 5*(2), e9. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5311421/

Buis, L. R., Artinian, N. T., Schwiebert, L., Yarandi, H., & Levy, P. (2015). Text messaging to improve hypertension medication adherence in African Americans: BPMED intervention development and study protocol. Retrieved from https://www.researchprotocols.org/2015/1/e1/pdf

Butts, J. B., & Rich, K. L. (2015). Philosophies and theories for advanced nursing practice (2nd ed.). Burlington, MA: Jones & Bartlett Learning.

Chaudhri, K., Kearney, M., Day, R. O., Rodgers, A., & Atkins, E. (2019). Effect of dose administration aids on adherence to self-administered medications: A systematic review protocol. *BMJ Open, 9*(10). Retrieved from https://bmjopen.bmj.com/content/bmjopen/9/10/e030536.full.pdf

Choudhry, N. K., Isaac, T., Lauffenburger, J. C., Gopalakrishnan, C., Lee, M., Vachon,

A.,…Sequist, T. D. (2018). Effect of a remotely delivered tailored multicomponent approach to enhance medication taking for patients with hyperlipidemia, hypertension, and diabetes: The STIC2IT cluster randomized clinical trial. *JAMA Internal Medicine, 178*(9), 1182–1189. https://doi.org/10.1001/jamainternmed.2018.3189

Conway, C. M., & Kelechi, T. J. (2017). Digital health for medication adherence in adult diabetes or hypertension: An integrative review. *JMIR Diabetes, 2*(2):e20. https://doi:10.2196/diabetes.8030

Davidson, T. M., McGillicuddy, J., Mueller, M., Brunner-Jackson, B., Favella, A., Anderson, A.,…Treiber, F. A. (2005). Evaluation of an mHealth medication regimen self-management program for African American and Hispanic uncontrolled hypertensives. *Journal of Personalized Medicine, 5*, 389-405. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4695862/pdf/jpm-05-00389.pdf

Finitsis, D. J., Pellowski, J. A., & Johnson, B. T. (2014). Text message intervention designs to promote adherence to antiretroviral therapy (ART): A meta-analysis of randomized controlled trials. *PLoS ONE, 9*(2), e88166. https://doi:10.1371/journal.pone.0088166

Hamdidouche, I., Jullien, V., Boutouyrie, P., Billaud, E., Azizi, M., & Laurent, S. (2017). Drug adherence in hypertension from methodological issues to cardiovascular outcomes. *Journal of Hypertension, 35*(6), 1133-1144. Retrieved from https://journals.lww.com/jhypertension/Fulltext/2017/06000/Drug_adherence_in_hypertension__from.2.aspx?casa_token=IDBlFkS9WfwAAAAA:Z8QdEIkkx6ebTBcGPuYDni78l4p7jzWTU4ZGjnpqVMmKH6W8PF64yJepyZq7T0_i5fUNWF5c2YdiXz2mXpY

Head, K. J., Noar, S. M., Iannarino, N. T., & Harrington, N. G. (2013). Efficacy of text

messaging-based interventions for health promotion: A meta-analysis. *Social Science & Medicine, 97,* 41-48. https://doi.org/10.1016/j.socscimed.2013.08.003

Hernandez-Vila, E. (2015). A review of the JNC 8 blood pressure guideline. *Texas Heart Institute Journal*, *42*(3), 226–228. https://doi.org/10.14503/THIJ-15-5067

Kamal, A. K., Shaikh, Q., Pasha, O., Azam, I., Islam, M., Memon, A. A.,…Khoja, S. (2015). A randomized controlled behavioral intervention trial to improve medication adherence in adult stroke patients with prescription tailored Short Messaging Service (SMS)-SMS4Stroke study. *BMC Neurology, 15,* 212. https://doi.org/10.1186/s12883-015-0471-5

Kassavou, A., & Sutton, S. (2017). Reasons for non-adherence to cardiometabolic medications, and acceptability of an interactive voice response intervention in patients with hypertension and type 2 diabetes in primary care: A qualitative study. *BMJ Open, 7,* e015597. Retrieved from https://bmjopen.bmj.com/content/bmjopen/7/8/e015597.full.pdf

Khan, M., Khan, S. M., & Dar, Z. R. (2017). Assessment of adherences to medication therapy in hypertensive patients and effect of patient counseling in tertiary care hospital. *Journal of Basic and Clinical Pharmacy, 8,* S041-S043. Retrieved from https://www.jbclinpharm.org/articles/assessment-of-adherences-to-medication-therapy-in-hypertensive-patients-and-effect-of-patient-counseling-in-tertiary-care-hospital.html

Khonsari, S., Subramanian, P., Chinna, K., Latif, L. A., Ling, L. W., & Gholami, O. (2015). Effect of a reminder system using an automated short message service on medication adherence following acute coronary syndrome. *European Journal of Cardiovascular Nursing, 14*(2), 170–179. https://doi.org/10.1177/1474515114521910

Lee, H. J., Jang, S., & Park, E. (2017). Effect of adherence to antihypertensive medication on

stroke incidence in patients with hypertension: A population-based retrospective cohort study. *BMJ Open, 7,* e014486. https://doi:10.1136/bmjopen-2016-014486

Morisky, D. E., Ang, A., Krousel-Wood, M., Ward, H. (2008). Predictive validity of a medication adherence measure for hypertension control. *Journal of Clinical Hypertension, 10*(5), 348-354. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/j.1751-7176.2008.07572.x

Morisky, D. E., Green, L. W., Levine, D. M. (1986). Concurrent and predictive validity of a self-reported measure of medication adherence. *Medical Care, 24*(1), 67-74.

Pew Research Center. (2018). Mobile fact sheet. Retrieved from http://www.pewinternet.org/fact-sheet/mobile/

Roldan, P. C., Ho, G. Y., & Ho, P. M. (2018). Updates to adherence to hypertension medications. *Current Hypertension Reports, 20,* 34. https://doi.org/10.1007/s11906-018-0830-x

Sarabi, R. E., Sadoughi, F., Orak, R. J., & Bahaadinbeigy, K. (2016). The effectiveness of mobile phone text messaging in improving medication adherence for patients with chronic diseases: A systematic review. *Iranian Red Crescent Medical Journal*, *18*(5), e25183. https://doi.org/10.5812/ircmj.25183

Schwebel, F. J., & Larimer, M. E. (2018). Using text message reminders in health care services: A narrative literature review. *Science Direct, 13,* 82-104. https://doi.org/10.1016/j.invent.2018.06.002

Strandbygaard, U., Thomsen, S. F., & Backer, V. (2010). A daily SMS reminder increases adherence to asthma treatment: A three-month follow-up study. *Respiratory Medicine 104,* 166-171. Retrieved from

https://www.sciencedirect.com/science/article/pii/S0954611109003242

Thakkar, J., Kurup, R., Laba, T., Santo, K., Thiagalingam, A., Rodgers, A.,…Chow, C. K. (2016). Mobile telephone text messaging for medication adherence in chronic disease: A meta-analysis. *JAMA Internal Medicine, 176* (3), 340-349. Retrieved from https://jamanetwork.com/journals/jamainternalmedicine/article-abstract/2484905

Varleta, P., Acevedo, M., Akel, C., Salinas, C., Navarrete, C., Garcia, A.,…Romero, K. (2017). Mobile phone text messaging improves antihypertensive drug adherence in the community. *Journal of Clinical Hypertension, 19,* 1276-1284. https://doi10.1111/jch.13098

Wald, D. S., Bestwick, J. P., Raiman, L., Brendell, R., Wald, N. J. (2014). Randomised trial of text messaging on adherence to cardiovascular preventive treatment (INTERACT Trial). *PLoS ONE, 9*(12): e114268. https://doi:10.1371/journal.pone.0114268

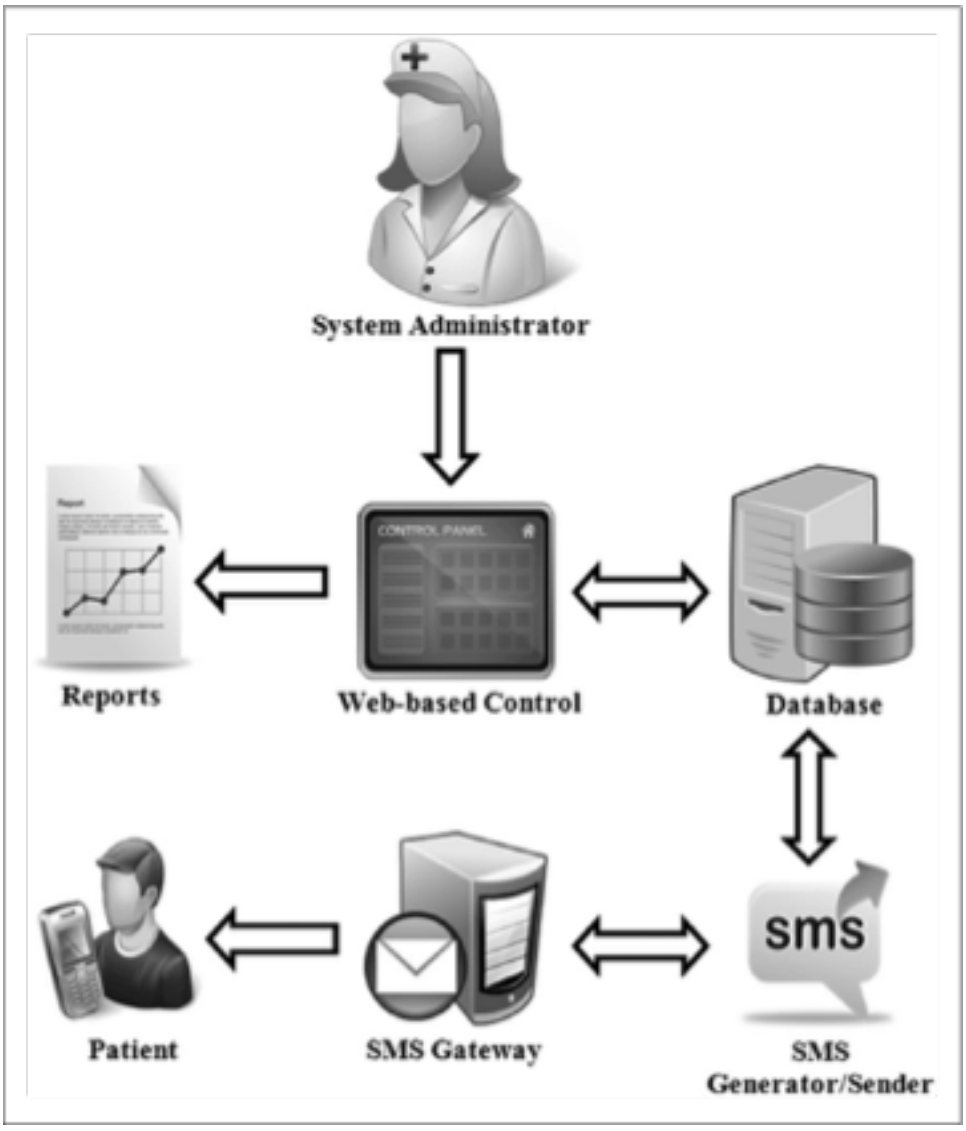
World Health Organization. (2011). MHealth new horizons for health through mobile technologies. Retrieved from https://www.who.int/goe/publications/goe_mhealth_web.pdf

World Health Organization. (2018). The top 10 causes of death. Retrieved from https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death

Zhang, Y., & Moran, A. (2017). Trends in the prevalence, awareness, treatment, and control of hypertension among young adults in the United States, 1999 to 2014. *Hypertension, 70*(4), 736-742. Retrieved from https://www.ahajournals.org/doi/full/10.1161/HYPERTENSIONAHA.117.09801

Appendix A

Automated Short Message Service (SMS)-based Reminder System Workflow Diagram



Source: Khonsari, S., Subramanian, P., Chinna, K., Latif, L. A., Ling, L. W., & Gholami, O. (2015). Effect of a reminder system using an automated short message service on medication adherence following acute coronary syndrome. *European Journal of Cardiovascular Nursing, 14*(2), 170–179.

Appendix B

A List of Mobile Phone Short Message Service Text Messages And The Day The Message Is Sent

	Content of message	Day
1	Remember to take the medication prescribed by your doctor following the recommended dose and schedule. Do not stop any tablet!	2
2	Blood pressure drugs act through different mechanisms. If you suspend a tablet, you will lose the action and can raise blood pressure	14
3	If you have a medication prescribed at night, remember to take it! The drug′s effect lasts some hours and if you forget this dose, blood pressure can rise	26
4	Remember that salt raises blood pressure. Decrease your intake of high-sodium products such as sausages, canned goods, and instant soups	38
5	Remember that your doctor knows your particular case and knows what you need to lower blood pressure. Take what you have been prescribed	50
6	How much blood pressure medicine do you have left? If you have only a few pills for this week, plan to obtain your medicine timely	62
7	Promptly take the medications your doctor prescribed, strictly following the schedule and doses indicated	74
8	If you feel that your blood pressure medicine causes you inconvenience, tell your doctor immediately for a change. Do not decide to change it by yourself	86
9	Do not stop treatment even if your blood pressure has returned to normal, or if you feel better, except on the advice of your doctor	98
10	Stress affects hypertension. Take space and moments of tranquility, and do not forget to take your medications at the time and dose indicated	110

	Content of message	Day
11	If you forget to take the morning medicine, do so as soon as possible. To avoid forgetfulness, leave it near your toothbrush or your breakfast cup	122
12	If you must take medication during working hours, program your cell phone alarm to remind you when appropriate	134
13	Have you tried eating bread without salt? If you do not like it, at least try to get the salt shaker off the table. That′s already an improvement.	146
14	If this week you have taken all your medications at the correct time and dose, congratulations!	158
15	By controlling blood pressure, you add years to your life. Remember to take your medications to control it. We want to take care of you!	170

Source: Varleta, P., Acevedo, M., Akel, C., Salinas, C., Navarrete, C., Garcia, A.,…Romero, K. (2017). Mobile phone text messaging improves antihypertensive drug adherence in the community. *Journal of Clinical Hypertension, 19,* 1276-1284.

Appendix C

Morisky Medication Adherence Scale (MMAS-8-Item)

	YES	NO
1. Do you sometimes forget to take your medications?		
2. People sometimes miss taking their medications for reasons other than forgetting. Over the past two weeks, were there any days when you did not take your medication?		
3. Have you ever cut back or stopped taking your medication without telling your doctor because you felt worse when you took it?		
4. When you travel or leave home, do you sometimes forget to bring your medication?		
5. Did you take all your medication yesterday?		
6. When you feel like your symptoms are under control, do you sometimes stop taking your medication?		
7. Taking medication every day is a real inconvenience for some people. Do you ever feel hassled about sticking to your treatment plan?		
8. How often do you have difficulty remembering to take all your medication? Never/Rarely…….0 Once in a while…….1 Sometimes…….2 Usually……..3 All the time……...4		

Source: Morisky, D. E., Ang, A., Krousel-Wood, M., Ward, H. (2008). Predictive validity of a medication adherence measure for hypertension control. *Journal of Clinical Hypertension, 10*(5), 348-354.

Appendix D

Morisky-Green-Levine Medication Adherence

	YES	NO
1. Do you ever forget to take your antihypertensive medicine?		
2. Are you careless at times about taking your medicines?		
3. When you feel better, do you sometimes stop taking your medicine?		
4. Sometimes if your feel worse when you take your medicine, do you stop taking it?		

Source: Morisky, D. E., Green, L. W., Levine, D. M. (1986). Concurrent and predictive validity of a self-reported measure of medication adherence. *Medical Care, 24*(1), 67-74.

Appendix E
Literature Matrix

Author, Year, and Journal	Title and Level of Evidence	Purpose or Article Question	Design/Sample	Data Collection Instruments/Procedures	Results/Findings	Limitations	Applicability to Project
Andre et al., 2019, *International Journal of Hypertension*	Mobile Phone-Based Intervention in Hypertension Management Level I	To critically appraise whether mobile phone-based interventions are effective in increasing adherence in hypertensive patients.	Systematic Review: 5 RCTs, 2 Systematic reviews Sample= 1729 **Inclusion:** Articles published within 5 years prior to the study **Exclusion** (none mentioned)	Data searching was performed in 3 databases: PubMed, Cochrane, and ProQuest on December 15th 2018. Only articles published in the last 5 years were included. The terms found in PICO were formulated using Boolean technique. Relevant articles were appraised based on the critical appraisal guideline by Centre for Evidence-Based Medicine (CEBM), Oxford University, obtained from http://www.cebm.net/critical-appraisal/. Critical appraisal was carried out on all selected articles. To measure the level of adherence, studies used a variety of parameters such as pharmacy refill rate, the timing of the opening of a drug container lid (with embedded microchip), independent blood pressure measurements and the result of patients' blood pressure reduction or through a Morisky adherence questionnaire.	We found that the reduction of blood pressure in participants who were given reminder through mobile phones was greater in comparison to control: systolic (94.4% vs 41.2%, p 0.003), diastolic (94.4% vs 76.5%, p 0.04). Patients who were nonadherent at baseline benefit more from mobile phone-based intervention in comparison to adherent patients at baseline: RR 2.3 (95% CI: 1.4-4.4, p<0.001) vs RR 1.3% (95% CI: 1.0-1.6, p<0.05).	Small number of studies included limits generalizability of the findings.	Mobile phone-based interventions were effective in increasing medication adherence in hypertensive patients. Clinical practice guidelines should consider this nonpharmacological method for a better blood pressure regulation.
Buis et al., 2017, *JMIR mHealth and uHealth*	Text Messaging to Improve Hypertension Medication Adherence in African Americans From Primary Care and Emergency Department Settings: Results from Two Randomized Feasibility Studies Level II	To determine the feasibility, acceptability, and preliminary clinical effectiveness of BPMED, an intervention designed to improve medication adherence among African Americans with uncontrolled HTN, through fully automated text messaging support.	RCTs Primary care=58 Sample: Mean age= 52.2 Female 46% ED participants=65 Mean age=46.3 Female=66% **Inclusion:** African Americans, 18 or older, dx of uncontrolled HTN, taking at least one antihypertensive medication, have cell phone with text messaging, speak English **Exclusion:** Strict adherence to antihypertensive medication, hemodialysis pts, plans to move or terminate cell phone, other major health problem, resistant hypertension	Participants completed self-reported assessments either in paper format or electronically via study-furnished laptops. The primary outcome measure was medication adherence as quantified by the Morisky Medication Adherence Scale (MMAS). Pill counts were obtained as a second measure of medication adherence. Secondary outcome measures included BP and medication adherence self-efficacy, as well as participant satisfaction.	BPMED participants consistently showed numerically greater, yet nonsignificant, improvements in measures of medication adherence (mean change 0.9, SD 2.0 vs mean change 0.5, SD 1.5, P=.26), SBP (mean change –12.6, SD 24.0 vs mean change –11.3, SD 25.5 mm Hg, P=.78), and DBP (mean change –4.9, SD 13.1 mm Hg vs mean change –3.3, SD 14.3 mm Hg, P=.54). Control and BPMED participants had slight improvements to medication adherence self-efficacy (mean change 0.8, SD 9.8 vs mean change 0.7, SD 7.0) with no significant differences found between groups (P=.92). On linear regression analysis, baseline SBP was the only predictor of SBP change; participants with higher SBP at enrollment exhibited significantly greater improvements at one-month follow-up (β=–0.63, P<.001). In total, 94% (51/54) of BPMED participants agreed/strongly agreed that they were satisfied with the program, regardless of pilot setting.	Small sample sized that contributed to lack of statistically significant effects of BPMED on primary and secondary outcomes. BPMED uses a single component approach to improve medication adherence which was considered by the authors as a limiting factor.	Use of text message reminders to improve medication adherence is a feasible and acceptable approach among African Americans with uncontrolled HTN.

Author, Year, and Journal	Title and Level of Evidence	Purpose or Article Question	Design/Sample	Data Collection Instruments/Procedures	Results/Findings	Limitations	Applicability to Project
Conway & Kelechi, 2017, *JMIR Diabetes*	Digital Health for Adherence in Adult Diabetes or Hypertension: An Integrative Review Level I	To examine the types of digital health technologies that targeted medication adherence in the adult population with diabetes or hypertension and to determine if digital health technologies improve medication adherence in adults with diabetes or hypertension.	Integrative Review 13 studies: RCTs, Quasi-experimental, Observational N=3600 **Inclusion:** Studies containing digital health interventions to improve medication adherence to prescription medications in adults and focused on diabetes or hypertension. **Exclusion:** Studies that did not include results of medication adherence rates; pilot studies.	This integrative review adhered to the following five stages: (1) problem identification, (2) literature search, (3) data evaluation, (3) data analysis, and (5) presentation. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was used to depict the search results.	Strategies used to improve medication adherence included four primary approaches: IVR (with or without human interaction), SMS text messaging, telemonitoring and/or tailored care management, and Web-based software. Of the 13 studies included in this review, there was no conclusive demonstration of improved medication adherence using digital health interventions such as IVR, SMS text messaging, telemonitoring and remote monitoring, and interactive software technology. However, in some studies the benefits of digital health technology were short term or close to statistically significant; for example, benefits improved but were not statistically significant or there were benefits in both the intervention and control groups.	There is no consensus about methods to assess medication adherence, which makes it difficult to compare adherence rates across studies. The most frequently used method for assessing adherence is a self-report, but it is subjective and is often not as reliable as objective measurements such as serum drug level or pill count, although it is cost effective.	IVR, SMS text messaging, telehealth, and Web-based software are used in chronically ill patients via one-way communication to the patient or two-way communication between the patient and health care provider. Two-way communication can be used for timely reporting of monitored results, such as blood glucose and BP to the health care provider to receive feedback about care. There remains ample opportunity to enhance patient and provider communication via digital technology as new mobile and electronic media emerge.
Finitsis et al., 2014, *PLOS ONE*	Text Message Intervention Designs to Promote Adherence to Antiretroviral Therapy (ART): A Meta-Analysis of Randomized Controlled Trials Level I	To examine a quantitative comparison of text-message intervention designs to promote ART adherence.	Meta-analysis 8 RCTs Female= 49% African participants=65% Mean age=40 **Inclusion:** Studies that targeted ART adherence in a sample of people living with HIV, used RCTS, and reported at least one adherence measurement (i.e., self-report, pill count, electronic drug monitoring device, pharmacy refill) or biological outcome (i.e., viral load, CD4+ count) **Exclusion:** Studies were excluded when reported data were insufficient to calculate effect sizes and contacted authors were unable to provide the necessary additional data.	Serial searches of PsycINFO, PubMed, CINAHL, and ProQuest Dissertations and Theses for the years 1990 through October 2013, using Boolean strategy.	Eight studies, including 9 interventions, met inclusion criteria. Text-messaging interventions yielded significantly higher adherence than control conditions (OR=1.39; 95% CI=1.18, 1.64). Sensitivity analyses of intervention characteristics suggested that studies had larger effects when interventions (1) were sent less frequently than daily, (2) supported bidirectional communication, (3) included personalized message content, and (4) were matched to participants' antiretroviral therapy dosing schedule.	Small sample (8 studies) raises a risk of publication bias although with a validated methodological quality assessment tool, it was concluded that there was low overall risk of bias in individual studies. External validity scores were low in this sample of studies as few studies used random sampling of a representative frame in their design. Variation in the operationalization and measurement of adherence is also a limitation of the present study.	Text messaging can support antiretroviral therapy adherence. This system can be applied to optimize medication adherence for a wider spectrum of chronic diseases.

Author, Year, and Journal	Title and Level of Evidence	Purpose or Article Question	Design/Sample	Data Collection Instruments/Procedures	Results/Findings	Limitations	Applicability to Project
Head et al., 2013, *Social Science & Medicine*	Efficacy of text messaging-based interventions for health promotion: A meta-analysis Level I	To examine the efficacy of text messaging-based interventions to improve health behaviors and health-related outcomes. To examine potentially important moderators of text messaging-based interventions to begin to advance our understanding of what may make such interventions efficacious.	Meta-analysis 19 RCTs Mean follow-up=81.26 days 13 countries Sample=5958 Mean age=29.17 Females=64% **Inclusion:** Studies with intervention designed to change health behavior or for health promotion, include text messaging as a component, use RCTs and report on at least one behavioral outcome. **Exclusion:** Pilot studies that measured only psychosocial outcomes (e.g., attitudes, beliefs, stage or change, behavioral intention)	Comprehensive searches of CINAHL, Communication & Mass Media Complete, PsycINFO, and Medline computerized databases using various keywords applicable to this topic. Intercoder reliability was calculated as both the percentage of agreement between coders and Cohen's kappa, which corrects for chance categorizations.	The weighted mean effect size representing the impact of text messaging-based interventions on health behavior was d = .329 (95% CI = .274, .385; $p < .001$). This effect size indicates that text-messaging interventions had statistically significant effects on health behavior and health-related outcomes. This effect size was statistically heterogeneous ($Q_{18} = 55.60$, $p < .001$, $I^2 = 67.62$), and several variables significantly moderated the effects of interventions. Message tailoring and personalization were significantly associated with greater intervention efficacy. No significant differences were found between text-only interventions and interventions that included texting plus other components. Interventions that used an individualized or decreasing frequency of messages over the course of the intervention were more successful than interventions that used a fixed message frequency.	Only RCTs are included in the meta-analysis which almost certainly increased the internal validity of the findings, but it may have decreased the external validity of the meta-analysis. Also, while analyses of moderators can be revealing, they can also potentially be misleading given that such characteristics (e.g., use of personalization) are not randomly dispersed across studies. In addition, several moderator analyses had small groups of studies in some cells and thus should be interpreted with caution. The meta-analysis is focused on health promotion interventions and excluded chronic disease management interventions.	The effect size indicates that text-messaging interventions had statistically significant effects on health behavior and health-related outcomes (e.g., SMS to improve malaria chemoprophylaxis compliance - the result of this study can be translated to hypertension). Interventions targeting preventive medications were less successful but only 2 studies included in these area. More research needed to show effect of text messaging on medication adherence.
Kamal et al., 2015, *BMC Neurology*	A randomized controlled behavioral intervention trial to improve medication adherence in adult stroke patients with prescription tailored Short Messaging Service (SMS)-SMS4Stroke study Level II	To test the effectiveness of SMS on improving adherence in stroke survivors in Pakistan.	RCT, 2 months Neurology Stroke Clinics N=200 (38 lost to follow-up) Mean age=64 (intervention) 71 (control) 135=male 65=female **Inclusion:** >18 years, history of stroke by neuroimaging, >1 month since last episode of stroke, use of at least 2 drugs, Modified Rankin score of 3 or less, patient or caregiver has cell phone, speak English or local Urdu **Exclusion:** impairment in reading or responding to SMS by the caregiver, dysfunction or malignancy, plans to travel outside the country within the two months of study	Medication adherence was self-reported using Urdu version of MMAS Blood pressure was measured via Mindray Datascope Equator in the CTU at registration visit and after interview to assess for variability due to stress with the participant sitting and relaxed Patient satisfaction was measured with a self-reported questionnaire based Roger's theory of Diffusion of Innovations which measured patient satisfaction as a percentage and another questionnaire based on previous literature which measured patient satisfaction and was also reported as proportions.	After 2 months, the mean medication score was 7.4 (95 % CI: 7.2–7.6) in the intervention group while 6.7 (95 % CI: 6.4–7.02) in the control group. The adjusted mean difference (Δ) was 0.54 (95 % CI: 0.22–0.85). The mean diastolic blood pressure in the intervention group was 2.6 mmHg (95 % CI; −5.5 to 0.15) lower compared to the usual care group.	The use of MMAS for the stroke patients having complex stroke medication regimen, instead of electronic pill boxes and biomarkers for outcome assessment is a limitation of the study. However, it would be erroneous to believe that the patients have consumed all the pills for that dose when they open the box. Another inherent limitation is the performance bias of an educational intervention; participants were not blinded to the reception of SMS and were all instructed and probably motivated to medication adherence than the control group. Another limitation is that the duration of the study did not allow measurement of biologic outcomes like stroke recurrence after the intervention.	A short intervention of customized SMS can improve medication adherence and effect stroke risk factors like diastolic blood pressure in stroke survivors with complex medication regimens living in resource poor areas.

Author, Year, and Journal	Title and Level of Evidence	Purpose or Article Question	Design/Sample	Data Collection Instruments/Procedures	Results/Findings	Limitations	Applicability to Project
Khonsari et al., 2015, *European Journal of Cardiovascular Nursing*	Effect of a reminder system using an automated short message service on medication adherence following acute coronary syndrome Level II	To investigate the effect of automated SMS-based reminders on medication adherence in patients after hospital discharge following acute coronary syndrome (ACS).	RCT Sample=62 **Inclusion:** admission in hospital for ACS (diagnosis of ACS), being discharged to home, have cell phone with text messaging **Exclusion:** discharged to a care facility or another health care facility, unable to read text messages, travel out of the country within 8 weeks of the study, diagnosed with cognitive impairment.	The patients were asked to complete the eight-item Morisky Medication Adherence Scale (MMAS-8-item). The MMAS-8-item instrument measured the primary outcome, which was non-adherence to cardiac medications due to reasons like forgetfulness, carelessness, feeling better, or feeling worse.	There was a higher medication adherence level in the intervention group rather than the usual care group, (χ^2 (2)=18.614, p<0.001). The risk of being low adherent among the control group was 4.09 times greater than the intervention group (relative risk =4.09, 95% confidence interval (CI) 1.82–9.18). A meaningful difference was found in heart functional status between the two study groups with better results among patients who received SMS reminders, (χ^2 (1) = 16.957, p<0.001).	The short follow-up, single center setting and small sample size due to the time constraint limits generalizability of the study findings. Hence, further research that includes more participants from multiple centers with a longer follow-up duration is needed to confirm the present results.	An automated SMS-based reminder system can potentially enhance medication adherence in ACS patients during the early post-discharge period. Since poor adherence is not only an issue relating to cardiac medication therapy, it is suggested that this system can be applied to optimize medication adherence for a wider spectrum of chronic diseases including hypertension.
Strandbygaard et al., 2010, *Respiratory Medicine*	A daily SMS reminder increases adherence to asthma treatment: A three-month follow-up study Level II	To examine the impact of receiving a daily text message reminder on one's cell phone on adherence to asthma treatment.	RCT Sample=26 Male=26% Mean age= 32 **Inclusion:** diagnosis of asthma based on a clinical history and daily symptoms, age 18-45 years, and a positive methacholine challenge test with $PD_{20} \leq 4$ μmol **Exclusion:** patients with co-morbidities and a smoking history of more than 10 pack years.	The medicine administration count on the inhaler device was registered at week 4 and 12 and adherence rate was registered as the percentage of the medicine actually taken by the patients, calculated from the medicine dose-count on the discos Seretide and the number of days between clinical examinations: (60 − dose-count)/2 × days × 100%. Pharmacy reports were collected from www.sundhed.dk, where all pharmaceutical transactions within the last two years are registered. In the present study, the time to collect the prescribed medicine was noted.	The mean adherence rate in the SMS group increased from 77.9% to 81.5%; mean change = 3.6%, 95% CI (−8.5–15.7%), p = 0.52, whereas the mean adherence rate in the control group decreased from 84.2% to 70.1%; mean change = −14.2%, 95% CI (−24.2–4.1%), p = 0.01. The absolute difference in mean adherence rate between the two groups after 12 weeks was 17.8%, 95% CI (3.2–32.3%), p = 0.019.	The study had a limited sample size and a short follow up period, therefore further studies with more participants and a longer follow-up are required before any unambiguous conclusions and a cost-benefit profile can be made regarding the effect on clinical outcomes. The validity of adherence measurement was based upon participant credibility regarding possible dose-dumping on the discos Seretide and is a possible limitation of the study.	A daily SMS reminder was found to have a significant effect on adherence to asthma treatment. As non-adherence is not only problematic in respect to asthma treatment, it also opens the possibility for a daily SMS reminder to improve adherence to treatment regimens across a larger spectrum of chronic diseases.

Author, Year, and Journal	Title and Level of Evidence	Purpose or Article Question	Design/Sample	Data Collection Instruments/Procedures	Results/Findings	Limitations	Applicability to Project
Thakkar et al., 2016, *JAMA Internal Medicine*	Mobile telephone text messaging for medication adherence in chronic disease: A meta-analysis Level I	To conduct a meta-analysis of randomized clinical trials to assess the effect of mobile telephone text messaging on medication adherence in adults with chronic medical disorders.	Meta-analysis 16 RCTs Sample= 2742 Median age= 39 Female=50.3% **Inclusion:** Patients ≥18 years with chronic disease, have a mobile telephone text message intervention designed to promote medication adherence, RCTs with at least 4 weeks' follow-up, and the trial reported quantitative measures of the effect of text messaging on medication adherence **Exclusion:** Primary intervention under consideration was not limited to text messages, the focus was solely disease management or education and did not report medication adherence or reported only surrogate outcomes, and the study involved psychiatric, military, or institutionalized patients. The latter criterion was to avoid the potential influence of psychosocial or institutional controls on adherence.	A computerized literature search of MEDLINE, EMBASE, CINAHL, PsycINFO, Cochrane Central Register of Controlled Trials, and trial registries (clinicaltrials.gov and ANZCTR [http://www.anzctr.org.au/]) was conducted using Medical Subject Headings and keywords. Cochrane Handbook for Systematic Reviews of Interventions was used as a guide during data extraction.	Text messaging significantly improved medication adherence (odds ratio, 2.11; 95% CI, 1.52-2.93; P < .001). The weighted mean effect size (Cohen d) was 0.41 (95% CI, 0.23-0.59) This increase translates into adherence rates improving from 50% (assuming this baseline rate in patients with chronic disease) to 67.8%, or an absolute increase of 17.8%. There was moderate heterogeneity ($I^2 = 62\%$) across clinical trials.	Variation in the characteristics of the interventions studied and in the definitions of outcomes among the studies. Most trials were of short duration and that most used self-reported outcome measures. Hence, uncertainty remains about the effect size of text messages over longer periods and on objective measures of outcome. Future research on the benefit of different features of text message interventions, the longevity of the effect, and the influence on objective clinical measures of outcomes are needed to help better identify the role of text message interventions to improve medication adherence in chronic disease care.	Mobile phone text messaging approximately doubles the odds of medication adherence.
Varleta et al., 2017, *Journal of Clinical Hypertension*	Mobile phone text messaging improves antihypertensive drug adherence in the community Level II	To evaluate whether the effect of a mobile phone text messaging intervention vs no text messaging (control) improves self-reported antihypertensive drug adherence in patients with hypertension recruited through primary care offices in Santiago, Chile.	RCT Sample=314 Women= 63.6% (control) 65.6% (SMS group) **Inclusion:** Patients with diagnosis of hypertension based on JNC 7 with first antihypertensive medication prescription during the previous 1-6 months; age 30-80 years; and who owned a mobile phone with text messaging. **Exclusion:** History of myocardial infarction, stroke, heart failure, and/or renal failure on dialysis, mental disabilities and/or patients who were unable to read.	Antihypertensive medication adherence was measured using the validated Spanish version of the Morisky-Green-Levine (MGL) questionnaire. Only patients who responded positively to the four questions were considered adherent. BP was measured with a validated electronic device (Omron HEM-742, Omron Healthcare) using JNC 7 guidelines. The inflation mechanism of the device was activated to perform three consecutive measurements with a 2-minute interval between each.	Overall, baseline and follow-up antihypertensive medication adherence rates were 54% and 57%, respectively. After 6 months, medication adherence decreased for the control group from 59.3% to 51.4%, although this difference was not statistically significant (P=.1). By contrast, adherence improved significantly in the SMS text message group from 49% to 62.3% (P=.01). The analysis of the patients with baseline adherence and nonadherence shows a significant increase in the baseline nonadherent group with SMS vs the non-SMS intervention The logistic regression model (risk ratio, 1.3; 95% confidence interval, 1.0–1.6 [P<.05]) showed that the SMS intervention improved antihypertensive medication adherence by 30% in the study population. Of note, a higher improvement in 6-month medication adherence probability was observed in the baseline nonadherent subgroup (risk ratio, 2.3; 95% confidence interval, 1.4–4.4 [P<.001]).	The study lacked statistical power due to sample size. The tool MGL questionnaire to assess medication adherence is used in the study that is not considered to be as accurate as pill count or electronic devices to evaluate adherence. Few patients from high socioeconomic strata were included, in whom the authors stated that there is lower risk of nonadherence as evidence suggests.	This study demonstrated that an educational intervention using mobile text messaging significantly improves self-reported antihypertensive medication adherence in a hypertensive population with <6 months of prescribed drug treatment. A potential implication of this study is the promotion of text messaging in a hypertensive population susceptible to low therapy compliance.

TEXT MESSAGING TO IMPROVE MEDICATION ADHERENCE AMONG HYPERTENSIVE PATIENTS: A STEP IN STROKE PREVENTION

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INTRODUCTION

ABSTRACT:

Background:
- Hypertension remains a prevalent public health concern
- Adherence to medications is suboptimal
- Traditional interventions not widely effective

Objective:
- To explore the effect of text messaging as a simple strategy to reduce nonadherence in hypertensive patients
- What is the relationship between text messaging and medication nonadherence among hypertensive patients?

Methods:
- CINAHL, Medline, and PubMED, Google Scholar. MeSH terms
- Eligible studies had to contain mobile telephone text messaging with the outcome of improved medication adherence in adults 18 years or older with hypertension
- Health Belief Model - theoretical framework

Results:
- 5 RCTs, 3 meta-analysis, 2 systematic reviews
- Limited studies (3 studies) on hypertension
- All 10 studies concluded that text message reminders improve medication adherence
- 2 studies not statistically significant results

Conclusion:
- Text messaging can improve medication adherence to antihypertensive medications.

BACKGROUND LITERATURE:

- HTN - 3rd most prevalent chronic illness
- HTN - leading risk for stroke, CHF, and renal failure
- Heart disease and stroke - 2 biggest killers worldwide
- Medication nonadherence - leading cause of uncontrolled hypertension
- Only 50% of hypertensive patients are adherent; forgetting is most common reason

RESULTS

Table 1. Key Findings

Thakkar et al., 2016	Text messaging significantly improved medication adherence in chronic disease such as hypertension, HIV, acute coronary syndrome, asthma, and diabetes (odds ratio, 2.11; 95% CI, 1.52-2.93; p< .001).
Head et al., 2013	Efficacy of text-messaging-based interventions for health promotion (including compliance with treatment) overall weighted mean effect size d = .329 (95% CI = .274, .385; p< .001).
Andre et al., 2019	Nonadherent patients with hypertension benefit more from mobile phone-based intervention than adherent patients at baseline: RR 2.3 (95% CI: 1.4-4.4, p<0.001 vs RR 1.3 (95% CI: 1.0-1.6, p<0.05); the reduction of blood pressure in participants who were given reminder through mobile phones was greater in comparison to control: systolic (94.4% vs 41.2%, p=0.003), diastolic (94.4% vs 76.5%, p=0.04).
Varletta et al., 2017	Found that medication adherence in hypertensive patients who received text messaging increased from 49% to 62.3% (p=0.1), RR 1.3%; 95% CI:1.0-1.6, p<0.05).

TEXT MESSAGING (TM):

- Daily or more times TM – smaller effects; maybe due to response fatigue
- Two-way, personalized, matched times – greater effects; maybe due to enhanced engagement
- Adherence not sensitive to text message characteristics

DISCUSSION

LIMITATIONS:

- Strength of evidence
- Need for larger samples and longer duration
- Self-reported measure of adherence with Morisky Medication Adherence Scale (MMAS)

CONCLUSIONS:

- TM can improve adherence in hypertensive patients
- TM can be implemented in primary care clinics
- TM is inexpensive, easy to use, instantaneous intervention

REFERENCES:

Andre, N., Wibawanti, R., & Siswanto, B. B. (2017). Mobile phone-based intervention in hypertension management. *International Journal of Hypertension,* 2019.https://doi.org/10.1155/2019/9021017

Buis, L. R., Artinian, N. T., Schwiebert, L., Yarandi, H., & Levy, P.(2015). Text messaging to improve hypertension medication adherence in African Americans: BPMED intervention development and study protocol. Retrieved from https://www.researchprotocols.org/2015/1/e1/pdf

Head, K. J., Noar, S. M., Iannarino, N. T., & Harrington, N. G. (2013). Efficacy of text messaging-based interventions for health promotion: A meta-analysis. *Social Science & Medicine, 97,* 41-48. https://doi.org/10.1016/j.socscimed.2013.08.003

Thakkar, J., Kurup, R., Laba, T., Santo, K., Thiagalingam, A., Rodgers, A.,…Chow, C. K. (2016). Mobile telephone text messaging for medication adherence in chronic disease: A meta-analysis. *JAMA Internal Medicine, 176* (3), 340-349. Retrieved from https://jamanetwork.com/journals/jamainternalmedicine/ article-abstract/2484905

Varleta, P., Acevedo, M., Akel, C., Salinas, C., Navarrete, C., Garcia, A.,…Romero, K. (2017). Mobile phone text messaging improves antihypertensive drug adherence in the community. https://doi10.1111/jch.13098