Evaluating the Use of Telehealth to Manage Hypertension in Primary Care

Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Nursing Practice at the University of Kentucky

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2021

Abstract

Background: Hypertension remains one of the most common chronic conditions in the United States leading to several health complications and immense financial burdens, yet it remains grossly undertreated despite the availability of evidence-based treatment options. The 2017 guidelines from the American College of Cardiology and American Heart Association recommended the use of home blood pressure monitoring with a telehealth component as an adjunct to regular hypertension treatment; however, implementing this into practice can be difficult depending on the setting, available resources, and the knowledge and skills of the providers. **Aims:** The purpose of this investigation is to evaluate patient adherence of measuring and logging blood pressure on the electronic medical record patient portal and the provider offering feedback regarding treatment. A secondary aim is to evaluate blood pressure trends of patients pre- and post-intervention. **Methods**: A retrospective and prospective study was completed to evaluate patient and provider adherence to using the recommended home blood pressure monitoring with telehealth transmission. The goal was for patients to take and log blood pressure daily for a minimum of two weeks. The number of blood pressures used to assess adherence was 12 blood pressures in a one-month period. The provider was expected to follow up anytime within the month period. Change in systolic and diastolic blood pressure was also assessed. **Results:** Nine patients met the inclusion criteria and all nine patients participated in the telehealth intervention. Six (66.7%) were adherent and logged at least 12 blood pressures, seven (77.8%) logged at least 11 blood pressures and two participants (22.2%) logged no blood pressure measurements. Provider feedback was given to the seven participants (77.8%) who logged data. All patients who logged blood pressure measurements were within goal or near goal at the end of the intervention. **Discussion/Implications:** High levels of provider and patient adherence to the intervention suggest this intervention was an acceptable and feasible

cointervention for the management of hypertension in the primary care setting and could be successful for the other patients with hypertension in this clinic and beyond.

Acknowledgements

Throughout this project I have received a great deal of help and support.

I would like to first thank my academic advisor, Dr. Elizabeth Tovar, PhD, RN, FNP-C, who helped guide and direct the research question and objectives. Your feedback and support allowed me to take my project to the next level. Thank you for helping me articulate my thoughts and convey my message.

I would like to thank the clinical members. Thank you to Dr. Tyler Browning, MD, for not only agreeing to help me execute this project but for being so invested over these past months. I would not be at this point if it were not for your support. Also thank you to Dr. Anne Blank, for agreeing to participate in the patient education. Your expertise to the patient education was invaluable.

I would like to thank my committee member Dr. Lynne Jensen, PhD, RN, APRN, thank you for your knowledge and guidance throughout this project. Your wisdom has allowed me to achieve my project goals.

Next, I would like to thank Dr. Amanda Thaxton Wiggins for your guidance and expertise on interpreting and analyzing data as well Whitney Kurtz-Ogilvie, your expert knowledge to allow me to convey my message in writing.

Finally, I would like to thank all the professors and faculty at the University of Kentucky as well as all my preceptors throughout this program.

Dedication

This is dedicated to my mom and dad, my sisters Samantha, Sara, and Alana and my fiancé Jake. Thank you for all the love and support you have provided me through my education and everything I do. I would not be here without you.

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Problem Statement/Background/Significance

Uncontrolled hypertension remains a significant problem in the United States despite the fact that in most patients, this condition can be well-managed with lifestyle changes and pharmacological interventions. Untreated or undertreated hypertension can lead to devastating health consequences including death and puts a heavy burden on the healthcare system (Centers for Disease Control and Prevention [CDC], 2020). In 2020, almost one half of the adults in the United States had a diagnosis of hypertension; this has increased from one third of adults in 2016 (CDC, 2016, 2020). Hypertension costs the U.S. about $131 billion each year from health care services, medications and missed days of work (CDC, 2020). Hypertension increases the risk for stroke and heart disease, the leading cause of death in the United States. Moreover, only about one half of adults with hypertension have attained blood pressure control (CDC, 2016). Barriers to successful management of hypertension include suboptimal medication dosage/therapy inertia (lack of medication changes after initial diagnosis and treatment was developed), lack of patient engagement, non-adherence to treatment recommendations and limited resources to educate patients on lifestyle changes (Milani et al., 2016).

One factor that contributes to uncontrolled hypertension is under treatment or conservative management of hypertension by providers. This occurs for several reasons. For example, Mu and Mukamal (2016) found that some of these reasons may occur due to competing demands of primary care providers, a growing number of clinical practice guidelines with conflicting recommendations, and short clinic visits. Additional factors that may contribute to uncontrolled

hypertension include previous visits with well-controlled blood pressure, side effects from medications, a patient's informed decision declining the intensification of therapy and the initiation of lifestyle interventions. Mu and Mukamal (2016) found that in several ambulatory clinics across diverse demographics, providers rarely intensified antihypertensive therapy for patients with an elevated blood pressure. For a systolic blood pressure greater than 120 mm Hg, only 11% of patients received treatment intensification (9.7 million out of a potential 88.4 million). A higher prevalence of intensification occurred for those with higher blood pressure. Of those with a systolic blood pressure greater than 160 mm Hg, only 2.5 million out of 9.7 million (25.2%) had treatment intensified. This indicates that patients with higher blood pressures were more likely to receive intensification of therapy but mild to moderately elevated blood pressures were not treated with such urgency. This potential treatment inertia can lead to devasting health outcomes. Timely intensification of medication may help improve hypertension-related morbidity and mortality nationwide (Mu & Mukamal, 2016). Recent research indicates that treatment intensification improves hypertension management even with suboptimal adherence with a reduction of cardiovascular events and deaths (Mu & Mukamal, 2016).

Chronic illnesses require patient engagement to achieve maximum benefit and control of the condition. Patient engagement has been shown to be an indicator of high-quality care, lower cost, and better health. This has been shown to be dose dependent, i.e., the higher the engagement the better the outcomes (Kaplan et al, 2017). Telehealth can be used as an effective method to facilitate patient engagement. The Centers for Medicare and Medicaid Services' (CMS) electronic health records (EHR) incentive program, "Meaningful Use" encourages the use of health information technology to promote patient engagement and provide a better understanding of their care (CMS, 2012).

Telehealth is a broad term used to define healthcare provided remotely. There are four types of telehealth branches. Synchronous telehealth includes a video visit or live chat with the patient and provider. Care is provided in real time. Remote patient monitoring (RPM) allows providers to view data collected from the patient remotely, such as vital signs. This form of telehealth is often recommended for patients with chronic conditions. Asynchronous telehealth, or store-and-forward, allows the transmission of patient health information to another healthcare provider. Mobile health, or mHealth, utilizes smart devices that can collect data about a person's health (e.g., heart rate, pulse ox, movement tracking and sleep cycles) to promote healthy behaviors (Pennic, 2015). Often a combination of two or more types of telehealth are used to provide remote healthcare to patients.

Out-of-office blood pressure monitoring is useful with a cointervention such as telehealth or counseling to diagnose and manage pharmacological therapy of hypertension (Whelton, 2017). The 2017 Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults gave a Grade I recommendation for the use of out-of-office blood pressure measurements to help confirm and titrate medications with telehealth counseling or clinical interventions. An additional Grade IIA recommendation was given on the use of telehealth strategies in addition to usual care intervention to reduce blood pressure in adults with hypertension (Whelton et al., 2017). The effects of various telehealth interventions for lowering blood pressure were significantly greater than blood pressure self-monitoring without transmission suggesting the importance of the teletransmission approach and timelier provider feedback. Telehealth has not been demonstrated to be an effective standalone strategy to manage hypertension; however, telehealth with cointerventions has been shown to be an effective adjunct in the management of hypertension (Whelton et al., 2017).

Purpose/Objectives

In a Northern Kentucky community hospital primary care clinic, a physician champion identified suboptimal control of hypertension as an important clinical problem. Specifically, the issue of patients who present with elevated blood pressure in the office but report their blood pressure is well controlled at home. This is reported as a common occurrence and presents a clinical dilemma of whether or not to intensify pharmacological therapy. The goal of this project was to develop and implement an evidence-based intervention to identify patients who have controlled hypertension versus those who have truly elevated blood pressure requiring intensification of pharmacological therapy and closer follow-up care. A preliminary review of the literature revealed that out-of-office blood pressure with a component of telehealth can be effective in managing hypertension. The goal was to pilot the implementation of home-blood pressure monitoring with the transmission of data using the MyChart® application, which is linked to Epic®, the electronic health records (EHR) system used by the facility, to assess adherence to daily blood pressure monitoring and logging the data in the EHR and gauge the potential feasibility of implementing this intervention.

The primary objective is to evaluate patient adherence to a regimen of taking and logging 12 blood pressures in a 4-week period on the application and the provider offering feedback within that month regarding treatment. A secondary objective is to evaluate blood pressure trends among patients pre- and post-intervention.

Theoretical Framework

The health belief model (HBM) was developed in the 1950s by social scientists at the United States Public Health Service to understand people's failure to adopt disease prevention strategies or screening tests, factors that impact a person's response to symptoms, and the

barriers and facilitators of adherence with recommended treatment (Rosenstock, 1974; LaMorte, 2019). The six tenets of the HBM are perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action and self-efficacy (LaMorte, 2019). The HBM suggests that a person's belief in the effectiveness of the recommended health behavior or action will predict the likelihood that the person will adopt the behavior. The HBM assumes that individuals have the desire to avoid illness, and the belief that a specific health action will prevent, or cure illness will influence their associated health behaviors. An individual's response often depends on the person's perception of the benefits and barriers of a health behavior (LaMorte, 2019).

This model was ideal for this project because of the nature of the intervention. Each tenet of the HBM was addressed to help maximize patient adherence to the intervention (figure 1). Home blood pressure monitoring and telehealth logging are largely patient dependent. Provider education with the patient focused on the severity of the uncontrolled condition as well as the long-term health effects. Patients might not fully understand the potential consequences of untreated or undertreated hypertension as they might not have any symptoms. Also, the use of the MyChart application allows a graph view (see Appendix A) for the patient to see how their blood pressure is trending. This allowed the patient to have a visual representation of their health which served as a cue to action. The education given by the physician champion focused on the patient's perceived severity of the illness. Discussing the benefits of gaining control of hypertension with lifestyle changes and medication adherence was intended to help the patient focus on perceived benefits of controlling their hypertension with the use of home blood pressure monitoring and teletransmission of data. Education on how to perform the intervention, including the logging of blood pressure with the MyChart application was provided by a clinical pharmacist or medical assistant to help improve patient self-efficacy and self-management of

hypertension. Blood pressure cuffs were also purchased by the clinic for patients to borrow, to help negate some of the financial burden of purchasing a blood pressure cuff.

This intervention was performed in the patient's home which helped alleviate the potential barrier of setting up transportation and the financial cost of traveling to the clinic to obtain blood pressure readings. Cues to action are the stimulus needed to trigger a behavioral change (LaMorte, 2019). Patients might not perceive their blood pressure as a problem until the topic is brought up by a healthcare provider. Provider education and recommendation of a behavioral change acted as a cue to action. Seeing the trends and the improvement of logged blood pressure acted as a cue to action to sustain the changed behavior. The provider education helped address all six tenets of the health belief model to help the patients be successful with the self-management component of their hypertension.

Review of Literature

Method

A literature review was conducted using PubMed, with search terms hypertension, uncontrolled, telehealth, primary care, and mhealth. Additional filters for data retrieval included: adults age 19+, English language and published between 2015 and 2020. Sixteen articles were identified using these search criteria. Abstracts were reviewed for relevance; eight articles were eliminated for irrelevance to the study topic. These included articles focused on diabetes and chronic kidney disease. Two more articles were eliminated because they were clinical trial protocols enrolling patients for future studies and had not collected data. Six articles were selected and reviewed based on relevance to the topic.

Synthesis of Evidence

Six articles were reviewed to assess the usefulness and feasibility of telehealth and technology with home blood pressure monitoring. Pan et al. (2018), Buis et al. (2020) and Sheppard et al. (2020) evaluated changes in clinic blood pressure pre- and post-home blood pressure telemonitoring. A significant reduction in both systolic and diastolic blood pressure was found in the intervention group. Even more significant was a high rate of adherence to the intervention in the study by Pan et al. (2020) with 86.5% of participants in the intervention group completing more than 70% of the required transmissions of their blood pressure reading. Similarly, Buis et al. (2020) found that participants uploaded at least one blood pressure on 75% of study days and 40.1% were fully compliant on days between baseline and follow-up. According to a systematic review by Sheppard et al. (2020) patient self-monitoring was associated with greater reduction in systolic blood pressure compared to usual care, regardless of hypertension-related comorbidities at 12 months. High intensity interventions were more effective than low intensity interventions in patients with obesity and stroke. High intensity interventions included self-monitoring with an active intervention, including web based or telephone tools to provide feedback, or self-monitoring with significant tailored support, from a clinician or pharmacist indicating the importance of patient and provider engagement.

The Hyperlink trial conducted by Margolis et al. (2013) tested a 12-month intervention of home blood pressure with telemonitoring with pharmacist management in adults with uncontrolled hypertension which led to improved blood pressure control at six and twelve months. Beran et al. (2018) evaluated what contributed to the Hyperlink trial's success. Focus groups from patients and an interview with the pharmacist found that the key components of success were a strong patient/pharmacist relationship, individualized treatment plans and

frequent contact with the pharmacist. The frequent check-in with the pharmacist allowed for checkpoints to increase medication therapy and reinforce lifestyle modifications. Pan et al. (2018) also found that participants in the intervention group were more likely to receive medication changes than the control group, who received usual care (48.7% compared to 12.3%). Additional benefits of home blood pressure monitoring with telehealth transmission were increased patient awareness and involvement, as well as more data for the medical team which improves communication and coordination (Pan et al., 2018).

Perceived benefits and burdens of the use of digital self-management intervention used for reducing blood pressure were evaluated in a qualitative study conducted by Morton et al. (2018). Participants were asked open-ended questions and seven themes were identified. Some participants felt a benefit from seeing blood pressure readings, increased motivation for lifestyle modifications, and the benefit of better health after seeing the effects of medication and lifestyle changes. However, the participants also identified burdens of self-management including worrying about health, uncertainty about whether the readings were representative, the burden of making lifestyle changes and the burden of practicality (Morton et al., 2018). One limitation of the study was that an assessment of psychological factors such as reassurance, anxiety and uncertainty was not performed (Morton et al., 2018).

The reliability and accountability of patients to truthfully report blood pressures readings without the use of automatic transmission may be a concern for providers when recommending this type of intervention. However, this does not seem to be a clinically significant concern. Parker et al. (2018) found a correlation of texted blood pressures having both an ending zero in the systolic and diastolic blood pressure when compared to the automatic transmitted blood pressure. This occurred less than 2% of the time and was not believed to be clinically significant.

Another finding was the preference for a systolic blood pressure of 134 and diastolic blood pressure of 84 when alert cut offs were 135/85. This occurred less than 4% of the time and was also not thought to be clinically significant.

Identification of Knowledge Gap in Practice

The effectiveness of telehealth interventions and home blood pressure monitoring has been established in the literature and is recommended in the 2017 guidelines from the American College of Cardiology and the American Heart Association to reduce blood pressure in hypertensive patients. What has not been well established is if this type of intervention works better for some patient populations than for others. It is important to determine whether age, technological experience, rural versus urban location or socioeconomic status affect the benefit of the intervention. Different demographic factors are important components to adherence; however, these were not evaluated in this investigation.

The guideline reports uncertainty about which combinations of telehealth interventions work best such as auto transmission or, self-log. However, the key to success in all strategies was the timely provider follow-up and individualized care.

Methods

Project Design

The project design was a retrospective and prospective study of patients who tracked home blood pressure using the MyChart application from August 1, 2020 to March 1, 2021 at a Northern Kentucky nonacademic community hospital primary care clinic. A chart review was performed to extract data for evaluation.

Setting

Agency Description

The project was implemented at a community hospital primary care clinic in Northern Kentucky. There are four physicians working at the office. The physician champion typically treats twenty-two to thirty patients a day with visit duration ranging from ten to twenty minutes. Current workflow includes the medical assistant (MA) rooming patients and taking vital signs. The MA first takes an automatic blood pressure. If this blood pressure is elevated, the MA will then take a manual blood pressure. If this blood pressure is then elevated the MA will report the reading to the physician champion and the blood pressure will be rechecked at the end of the visit. Patients are currently being asked to use a paper log of blood pressures and bring it to each visit for review with the provider.

Congruence of Project to Institutions Mission

The hospital uses the model ICARE, which stands for Innovation, Collaboration, Accountability, Respect and Excellence to represent the core values of the healthcare institution. This project was congruent with the values of innovation, collaboration, and excellence. The project used technology as an innovative method to improve hypertension, a chronic condition, by using creative solutions recommended by current evidence-based guidelines to promote provider and patient accountability. The project used collaboration with the MD, Clinical Pharmacist, MA, and information technology (IT). The aim of this project was to provide the best care for the patient while encouraging patients and giving them the tools required to manage their chronic medical conditions.

Stakeholders and a Description of their Roles in the Project

The physician champion was a stakeholder in this project. The goal was to pilot the use of home blood pressure monitoring with data transmission with the ultimate goal of the entire practice utilizing telehealth management for improved blood pressure control. The physician champion was responsible for ordering home blood pressure monitoring for patients, making adequate adjustments to antihypertensive medication regimens and providing adequate follow up for patients.

The MA was responsible for taking the initial blood pressure and subsequent blood pressures as needed when the patient was roomed. The clinical pharmacist was responsible for educating the patient how to accurately obtain a home blood pressure reading and how to log blood pressure in the MyChart application. The administrative staff was responsible for setting up patient appointments and ensuring follow-up. The information systems department provided education to the physician on how to activate the blood pressure tracking feature on the MyChart application and provided a tip sheet for patients to remind them of the steps of the process if needed.

The patients were also stakeholders as hypertension is a chronic disease that requires patient participation to successfully manage. Patient buy-in was crucial as they were responsible for medication adherence and taking and recording their blood pressures.

Site-specific Facilitators and Barriers to Implementation

The CMS Meaningful Use Initiative requires the use of health information technology to promote patient engagement and communication of care. Encouraging patient and provider interaction as well as data transmission using the patient portal fills this measure. The clinic uses Epic and strongly encourages patients to enroll in the patient portal, MyChart.

Blood pressure control is a quality indicator measured at the clinic for each provider. Gaining control of hypertensive patients who were previously uncontrolled would reflect positively on the provider's care making the providers more willing to partake in the intervention.

Another facilitator is the national clinical quality measure (CQMS), the Merit-Based Incentive Payment System (MIPS) from the CMS. The measure is to be submitted once per performance period (12 months) for patients with diagnosed hypertension. The most recent quality code is used to generate performance calculation. This creates national pressure to adequately control hypertension (CMS, 2019).

As of 2020, providers are now able to bill for at home blood pressure monitoring creating an additional financial incentive. The current procedural guidelines now have two new currently procedural terminology (CPT) codes to support home blood-pressure monitoring (Berg, 2019). This acts as a financial incentive for providers to order home-blood pressure monitoring. One code will be for the initial education (99473) and the other code can be billed once a month for ongoing treatment decisions of reviewing the blood pressures (99474). To bill for this code, 28 blood pressure readings over a 30-day period with a minimum of 12 readings is required and was chosen as the minimum goal for blood pressures recorded in one month (Berg, 2019).

One of the largest barriers was achieving insurance coverage and patients obtaining blood pressure cuffs for home use. Some insurance plans do not cover home blood pressure monitoring devices therefore the patient would be expected to pay out-of-pocket for these monitors. The price range could be as little as $20 to over $100. Allowing the patient to borrow blood pressure cuffs at no cost helped negate the financial burden.

Sample

The target population was adult patients over the age of 18 years of age with a known or new diagnosis of hypertension whose blood pressure was not currently within goal range. Inclusion criteria for patient participation were: adults 18 years and older, patients of the physician champion, above goal blood pressure at office visit, MyChart activated, and having an in-person appointment within the study period. Patients who met these criteria were approached by the physician about performing the intervention (table 2). Those who were agreeable were then given an order to check home blood pressure with telehealth transmission. The sample for the study included all patients of the physician champion who were recommended to check blood pressure at home and log the readings using the MyChart application.

Procedure

IRB Approval

The study protocol was reviewed and approved as an exempt application by two institutional review boards at two separate institutions.

Description of Evidence Based Intervention

The evidence-based intervention assessed was the use of a telehealth strategy with home blood pressure monitoring. This study aimed to assess patient adherence to taking and logging home blood pressures using the MyChart application as well as adherence with provider follow-up of readings and possible interventions. Adults with out of goal blood pressure who met the inclusion criteria were asked to check blood pressures at home and log the results in the MyChart applications for a minimum of two weeks but could continue up to one month. Those who were agreeable received education from the clinical pharmacist or MA on how to properly check blood pressure using the device and how to log the data in the patient portal. An order was

placed in Epic enabling the patient flowsheet, which allowed blood pressure readings to be logged. Participants were asked to check blood pressure for a minimum of two weeks but could continue up to four weeks. By the end of the four weeks the provider would contact the patient via MyChart message to discuss plan of care such as to continue current therapy, increase medication, decrease medication, continue home blood pressure checks or to schedule an office visit. The follow up could be a telephone call, MyChart message, video visit or in person patient visit. Thresholds for extremely elevated or low blood pressures were set based on patient dependent risk and goals. Notifications would be sent through Epic to the provider if these triggers were meant to allow for early feedback and interventions.

Measures and Instruments

Measurement of patient blood pressure was recorded by the patients to assess the blood pressure trend. The number of blood pressures obtained by the patient in a two-week and four-week period was evaluated as well as overall trends of systolic and diastolic blood pressure. Follow up by the provider was assessed using the chart review tab in Epic. Provider follow-up as well as intervention provided was assessed.

Data Collection

Data were collected by performing a chart review in Epic. The provider champion carbon copied all participants who were asked to perform the intervention to the DNP student allowing access to the medical chart. The data included the demographic data, blood pressures recorded by patients over two and four weeks, the number of blood pressures taken in the given cycle, the communication from the provider to the patient as well as documentation of the communication from the provider to the patient. Data was stored in a password protected program, RedCap and a password protected computer to ensure patient confidentiality.

Data Analysis Plan

Descriptive statistics were used to analyze demographic data as well as data collected to evaluate the intervention. Data was placed in tables and graphs using excel to identify trends in the data.

Results

Nine patients met the inclusion criteria and were approached about participation in the intervention. All nine patients approached were agreeable to participate in the intervention during the data collection period. Complete demographic data is in table 2. Of the participants, seven were male (77.8%) and two were female (22.2%). Age was well distributed between the age of 25 to 75 years and older. All nine participants (100%) were Caucasian. Most participants, five individuals, had some version of public health insurance (55.6%) while three had private (33.3%) and one participant had no health insurance (11.1%). Six (66.7%) of the patients were on hypertensive medication prior to the intervention. The majority of participants were classified as obese (7, 77.8%) and had a comorbid diagnosis of hyperlipidemia (5, 55.6%). Most were nonsmokers (6, 66.7%) and did not have a diabetes diagnosis (8, 88.9%)

Evaluation of patient adherence to the interventions found that six participants (66.7%) completed a minimum of 12 blood pressures but only two participants (22.2%) completed 28 blood pressure measurements (figure 3 and 4). One participant (11.1%) had logged eleven blood pressures over the period and two participants (22.2%) logged no data over the period. Of the seven patients (77.8%) who completed any number of blood pressure logs, all participants received feedback from the provider within four weeks (figure 7). Of the seven, four (57.1%) were recommended to increase their medication, one was recommended to decrease medication

(14.3%) and two (28.9%) were recommended to make no changes to their current medication (figure 9).

A trend noting decrease in both systolic and diastolic blood pressure was noted when each were plotted in a line graph. Participants who had medication dosages increased were noted to have logged more blood pressure readings (figure 5 and 6) than those who did not have medication increased. The trend of systolic and diastolic blood pressure indicates that all patients had controlled or near controlled blood pressure by the end of the evaluation. Statistical analyses were not possible due to the small sample sizes.

Discussion

This investigation found high rates of adherence to blood pressure monitoring and logging as well as timely provider feedback. When looking at the primary objective of patients and provider adherence to taking blood pressure and logging, both patient and provider had high rates of adherences (figure 3 and 4). Overall patients were highly adherent to the intervention of taking and logging blood pressure with seven of the nine (77.8%) participants logging any amount of blood pressure and six (66.7%) logging the minimum of 12 blood pressures during the data collection period. Only two participants (22.2%) logged at least 28 blood pressure readings over the collection period. These results are consistent with other similar studies from Buis et al (2020) and Pan et al (2018) who also found high rates of adherence to monitoring home blood pressure and electronically logging blood pressure data.

This investigation found that younger participants were less likely to log blood pressure. Age (35-44 years old) was the only similarity between the two participants who did not log any blood pressure readings. This could have occurred for a variety of reason but may have occurred due to the health behaviors of the age group. Younger, generally healthy individuals may not

perceive elevated blood pressure as a concern. This is consistent with the results from Ma (2018) which found age was associated with differing self-care behaviors; middle-aged adults had better self-care behaviors than their younger counterparts. Future investigation should focus on age based perceived susceptibility and severity to assess if this link exists. Of the two participants with no logged blood pressures, one was male and on two antihypertensive medications and the other was female not on any medications.

All patients who participated in the study were Caucasian. This, however, is reflective of the population of the county of this primary care clinic. In 2019, 94% of the county population was Caucasian and 3% was Black or African American (The United States Census Bureau, 2019). This may be indicative that the intervention might not be effective for other demographic populations.

The wide range of ages of participants (table 3) of the study indicates that even with requirement of a smart phone and internet connection this intervention would be feasible for all ages. Technology did not likely play a large role in the intervention as patients were already enrolled in MyChart and had access to the internet with a smartphone prior to the intervention. Most patients are already enrolled in MyChart. Of the 2500 of the physician champions patients, 1932 (77.3%) are currently registered for the MyChart, indicating this intervention would be appropriate for most patients.

All seven patients who logged blood pressure received feedback from the provider (figure 7). After the initial feedback using MyChart messages, a variety of methods were used including additional MyChart messages, video visits and in person visits. A combination of methods were used for some patients. Patients and providers appeared to favor some component of MyChart messages which could indicate patients prefer this method because of the convenience of not

having to schedule an appointment or travel as frequently. This investigation only assessed the provider feedback within the month period but did not assess the time between provider feedback and intervention. Future studies should exam the length of time between each interactions as well as if those with higher levels of uncontrolled hypertension had more interaction between the provider.

When discussing with the physician champion he noted the intervention was easy to use and easily integrated into current clinic workflow. One benefit of the intervention was the blood pressures were automatically integrated into the EHR. He noted that the intervention helps keep patients accountable for their health but also helps to better guide treatment for these patients.

Changes in systolic and diastolic blood pressure was evaluated as well (figure 5 and 6). A reduction of both systolic and diastolic blood pressure was noted from the beginning to the end of the sample period. These results are consistent with prior studies from Pan et al. (2018), Buis et al. (2020) and Sheppard et al. (2020) who found that self-monitoring with electronic logging was an effective method to reduce systolic and diastolic blood pressure. It was noted that those requiring medication increases had a greater reduction than those who did not require medication increases. This was likely due to these participants having higher systolic and diastolic blood pressures requiring medication intensifications which was then reflective in the blood pressure after the medication changes were made. These participants also logged more blood pressures which likely was a result of the change in the plan of care and the desire to see the change in blood pressure readings. This investigation indicates that home blood pressure monitoring and telehealth logging is a successful cointervention to usual care, however, it should be noted that due to the small sample size statistical analyses could not be performed.

This study did not evaluate the attitudes and feelings towards home blood pressure monitoring with a telehealth component, however this is an important factor for patient adherence. Morton et al., (2018) found that patients had mixed views on the use of self-blood pressure monitoring. Some patients found a benefit of performing the intervention as they felt it was beneficial to leading to better health and motivated them to make lifestyle changes. Other participants felt a perceived burden to self-monitoring and logging as they worried about their health. These attitudes and feelings toward the intervention may have been a contributor to patient participation in this investigation and should be studies in future studies.

As a result of this investigation the physician champion has continued this intervention on other hypertensive patients to use this as a cointervention to usual care. He plans to share data collected from his patients as well as provide education on how to implement home blood pressuring measurement with a telehealth component. The ultimate plan is to implement this intervention office wide to all providers.

Implications

This pilot study shows promising evidence to suggest that the use of telehealth intervention in addition to usual care can be effectively implemented with high levels of patient and provider adherence for the management of hypertension in this clinical setting. Implementation of this intervention practice wide would likely be beneficial however conducting a longitudinal study with a much larger sample size would yield more robust evidence regarding patient and provider adherence to the intervention as well as changes in blood pressure. Future investigations should also focus on long-term control of patient blood pressure in clinic. Further evaluation on different demographic variables such as age and gender, financial status and educational background as it applies to adherence to the intervention may be beneficial to

determine if certain education techniques work better for different populations. This investigation did not assess these factors. Further assessment of patient and provider preference on preferred feedback would be helpful in determining telehealth strategies to ensure tailored intervention and sustained patient engagement.

Future studies should focus on patient and provider attitudes toward the intervention to determine potential barriers to the use of home blood pressure monitoring with a telehealth component. This would help with understanding widespread application of the intervention to different clinical settings.

Limitations

Several limitation to this study can be identified. First, the small sample size of the participants. All nine patients approached were agreeable to participate. Due to the small sample size inferential statistics could not be used to detect significance. The small sample may not be reflective of a larger population of patients. This study only evaluated Caucasian individuals and may not be reflective of other population groups. Contributing factors to the small sample size include using patients of only one provider and the COVID-19 pandemic. During the pandemic patients may have opted not to have in-person visits or follow-ups and the length of recruitment and may have favored video visits. Due to one of the pieces of inclusion criteria being the initial visit being in person this may have eliminated potential participants to the study.

Secondly, the Hawthorne effect may also have contributed to the high amount of patient adherence. Patients were aware that the provider was closely observing their blood pressures which may have increased patient adherence to measuring and logging blood pressures as well as medications and lifestyle changes which would have reflected in the blood pressure readings. Also, the number of blood pressures logged may have been increased because of the same effect.

However, Sheppard et al. (2020) found sustained blood pressure control at 12 months with the home blood pressure measurement and telehealth logging suggesting that this intervention is sustainable. Future longitudinal studies should focus on the sustained control of blood pressure in these patients at each clinical visit.

Thirdly, only patients with uncontrolled hypertension were included. It would have been beneficial to include all patients who had a diagnosis of hypertension to evaluate out of office control of blood pressure.

Conclusion

Hypertension is a treatable chronic condition but has high levels of suboptimal control nationwide (CDC, 2020). Uncontrolled hypertension can lead to high levels of mortality, morbidity and financial strain in the U.S. Several factors contribute to low levels of control including overly conservative treatment by providers, lack of patient engagement but also patients reporting out of office control of blood pressure (CDC, 2020). Patient's reporting-controlled blood pressure at home creates a clinical dilemma. The goal of this investigation was to implement an evidenced based intervention to assess blood pressure control to help guide treatment. The published evidence and clinical practice guidelines make recommendations to use home blood pressure monitoring with a telehealth component to increase patient engagement and out of office blood pressure measurements to direct care of hypertensive patients. A retrospective and prospective study was completed to evaluate the primary objective of assessing patient and provider adherence to the intervention as well as the secondary objective of improvement of systolic and diastolic blood pressure. Nine patients participated in the study with high levels of both patient and provider adherence to the intervention. The trend of systolic and diastolic blood pressure appeared to improve through the sampling period. High levels of provider and patient

adherence to the intervention as well as improved systolic and diastolic blood pressure suggest this intervention was an acceptable and feasible cointervention for the management of hypertension in the primary care. Further research should be done with larger sample sizes to confirm these results, assess the effects of different demographic variables as well as to evaluate patient and providers feelings toward the intervention.

References:

Beran M, Asche SE, Bergdall AR, Crabtree B, Green BB, Groen SE, Klotzle KJ, Michels RD, Nyboer RA, O'Connor PJ, Pawloski PA, Rehrauer DJ, Sperl-Hillen JM, Trower NK, Margolis KL. Key components of success in a randomized trial of blood pressure telemonitoring with medication therapy management pharmacists. J Am Pharm Assoc (2003). 2018 Nov - Dec;58(6):614-621. doi: 10.1016/j.japh.2018.07.001. Epub 2018 Aug 1. PubMed PMID: 30077564; PubMed Central PMCID: PMC6727963.

Berg, S. (2019, November 28). New year, new CPT codes for self-measured BP. Retrieved from https://www.ama-assn.org/practice-management/cpt/new-year-new-cpt-codes-self-measured-bp

Buis LR, Roberson DN, Kadri R, Rockey NG, Plegue MA, Danak SU, Guetterman TC, Johnson MG, Choe HM, Richardson CR. Understanding the Feasibility, Acceptability, and Efficacy of a Clinical Pharmacist-led Mobile Approach (BPTrack) to Hypertension Management: Mixed Methods Pilot Study. J Med Internet Res. 2020 Aug 11;22(8):e19882. doi: 10.2196/19882. PubMed PMID: 32780026; PubMed Central PMCID: PMC7448180.

Centers for Disease Control. (2020, September 08). Facts About Hypertension. Retrieved October 25, 2020, from https://www.cdc.gov/bloodpressure/facts.htm

Centers for Disease Control. (2016, June 16). High Blood Pressure Fact Sheet|Data & Statistics|DHDSP|CDC. Retrieved from https://www.cdc.gov/dhdsp/data_statistics/fact_sheets/fs_bloodpressure.htm

CMS. (2019). Quality ID #236 (NQF 0018): Controlling High Blood Pressure. Retrieved from

https://qpp.cms.gov/docs/QPP_quality_measure_specifications/CQM-Measures/2020_Measure_236_MIPSCQM.pdf

CMS. Medicare and medicaid programs; Electronic health record incentive program—stage 2, 2012. https://www.cms.gov/Regulations-and Guidance/Legislation/EHRIncentivePrograms/Stage_2.html.

Kaplan, A. L., Cohen, E. R., & Zimlichman, E. (2017). Improving patient engagement in self-measured blood pressure monitoring using a mobile health technology. Health information science and systems, 5(1), 4. https://doi.org/10.1007/s13755-017-0026-9

LaMorte, W. (2019, September 19). Behavioral Change Models. Retrieved October 30, 2020, from https://sphweb.bumc.bu.edu/otlt/mph-modules/sb/behavioralchangetheories/behavioralchangetheories2.html

Ma, Chunhua. (2018). An investigation of factors influencing self-care behaviors in young and middle-aged adults with hypertension based on a health belief model. Heart & Lung, 47(2), 136-141.

Margolis, K. L., Asche, S. E., Bergdall, A. R., Dehmer, S. P., Groen, S. E., Kadrmas, H. M., Kerby, T. J., Klotzle, K. J., Maciosek, M. V., Michels, R. D., O'Connor, P. J., Pritchard, R. A., Sekenski, J. L., Sperl-Hillen, J. M., & Trower, N. K. (2013). Effect of home blood pressure telemonitoring and pharmacist management on blood pressure control: a cluster randomized clinical trial. JAMA, 310(1), 46–56. https://doi.org/10.1001/jama.2013.6549

Milani, Richard V., MD, Lavie, Carl J., MD, Bober, Robert M., MD, Milani, Alexander R, & Ventura, Hector J., MD. (2016). Improving Hypertension Control and Patient Engagement Using Digital Tools. The American Journal of Medicine, 130(1), 14-20.

Morton K, Dennison L, Bradbury K, Band RJ, May C, Raftery J, Little P, McManus RJ, Yardley

L. Qualitative process study to explore the perceived burdens and benefits of a digital intervention for self-managing high blood pressure in Primary Care in the UK. BMJ Open. 2018 May 8;8(5):e020843. doi: 10.1136/bmjopen-2017-020843. PubMed PMID: 29739782; PubMed Central PMCID: PMC5942415.

Mu, L., & Mukamal, K. J. (2016). Treatment Intensification for Hypertension in US Ambulatory Medical Care. Journal of the American Heart Association, 5(10). doi: 10.1161/jaha.116.004188

Pan F, Wu H, Liu C, Zhang X, Peng W, Wei X, Gao W. Effects of home telemonitoring on the control of high blood pressure: a randomised control trial in the Fangzhuang Community Health Center, Beijing. Aust J Prim Health. 2018 Nov;24(5):398-403. doi: 10.1071/PY17187. PubMed PMID: 30131099.

Parker RA, Paterson M, Padfield P, Pinnock H, Hanley J, Hammersley VS, Steventon A, McKinstry B. Are self-reported telemonitored blood pressure readings affected by end-digit preference: a prospective cohort study in Scotland. BMJ Open. 2018 Jan 31;8(1):e019431. doi: 10.1136/bmjopen-2017-019431. PubMed PMID: 29391369; PubMed Central PMCID: PMC5878245.

Pennic, J. (2015, August 13). 4 types of Telehealth Solution: Telehealth: HIT CONSULTANT. Retrieved February 27, 2021, from https://hitconsultant.net/2015/08/13/4-types-of-telehealth-solutions/#.YDqV02hKhPZ

Rosenstock, Irwin M. (1974). Historical Origins of the Health Belief Model. Health Education & Behavior, 2(4), 328-335.

Sheppard JP, Tucker KL, Davison WJ, Stevens R, Aekplakorn W, Bosworth HB, Bove A, Earle

K, Godwin M, Green BB, Hebert P, Heneghan C, Hill N, Hobbs FDR, Kantola I, Kerry SM, Leiva A, Magid DJ, Mant J, Margolis KL, McKinstry B, McLaughlin MA, McNamara K, Omboni S, Ogedegbe O, Parati G, Varis J, Verberk WJ, Wakefield BJ, McManus RJ. Self-monitoring of Blood Pressure in Patients With Hypertension-Related Multi-morbidity: Systematic Review and Individual Patient Data Meta-analysis. Am J Hypertens. 2020 Mar 13;33(3):243-251. doi: 10.1093/ajh/hpz182. PubMed PMID: 31730171; PubMed Central PMCID: PMC7162426.

The United States Census Bureau. (2019). U.S. census bureau quickfacts: Campbell County, Kentucky. Retrieved March 23, 2021, from https://www.census.gov/quickfacts/fact/table/campbellcountykentucky/PST045219

Whelton, P., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Hummelfarb, C. D., … Wright, J. T. (2018).2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Hypertension, 72(3). doi: 10.1161/hyp.0000000000000080

Tables

Table 1

Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Adults 18 and older	Blood pressure within goal
Patients of the physician champion	
Above goal BP at office visit	
MyChart activated	
Appointment within study period	
Initial in-person visit	

Table 2

Descriptive summary of participant characteristics (N = 9)

Characteristics	n (%)
Age	
18-24 years old	0 (0%)
25-34 years old	1 (11.1%)
35-44 years old	2 (22.2%)
45-54 years old	2 (22.2%)
55-64 years old	1 (11.1%)
65-74 years old	2 (22.2%)
75+ years old	1 (11.1%)
Sex	
Male	7 (77.8%)
Female	2 (22.2%)
Ethnicity	
White	9 (100%)
Hispanic or Latino	0 (0%)
Black or African American	0 (0%)
Native American or American Indian	0 (0%)
Asian/Pacific Islander	0 (0%)
Type of Health Insurance	
Private	3 (33.3%)
Public	5 (55.6%)
No Insurance	1 (11.1%)
Marital Status	
Single, never married	0 (0%)
Married or domestic partnership	8 (88.9%)
Widowed	0 (0%)
Divorced	1 (11.1%)
Separated	0 (0%)
Smoker	
Yes	3 (33.3%)
No	6 (66.7)
Diabetic	
Yes	1 (11.1%)
No	8 (88.9%)
Hyperlipidemia	
Yes	5 (55.6%)
No	4 (44.4%)
Obesity	
Yes	7 (77.8%)
No	2 (22.2%)
Hypertensive Medication Prior	
Yes	6 (66.7%)
No	3 (33.3%

Figures

Figure 1

Health Belief Model as it Pertains to Home Blood Pressure Monitoring with Telehealth

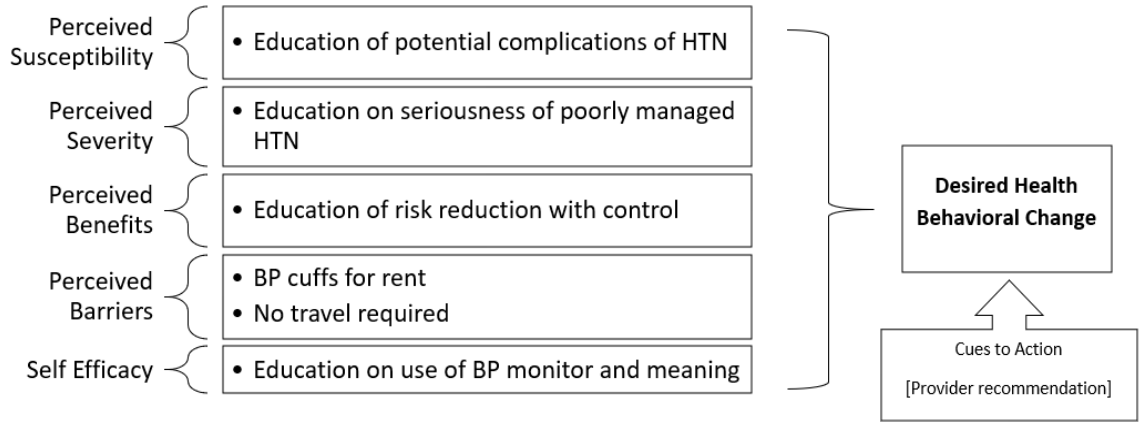


Figure 2

Project Design

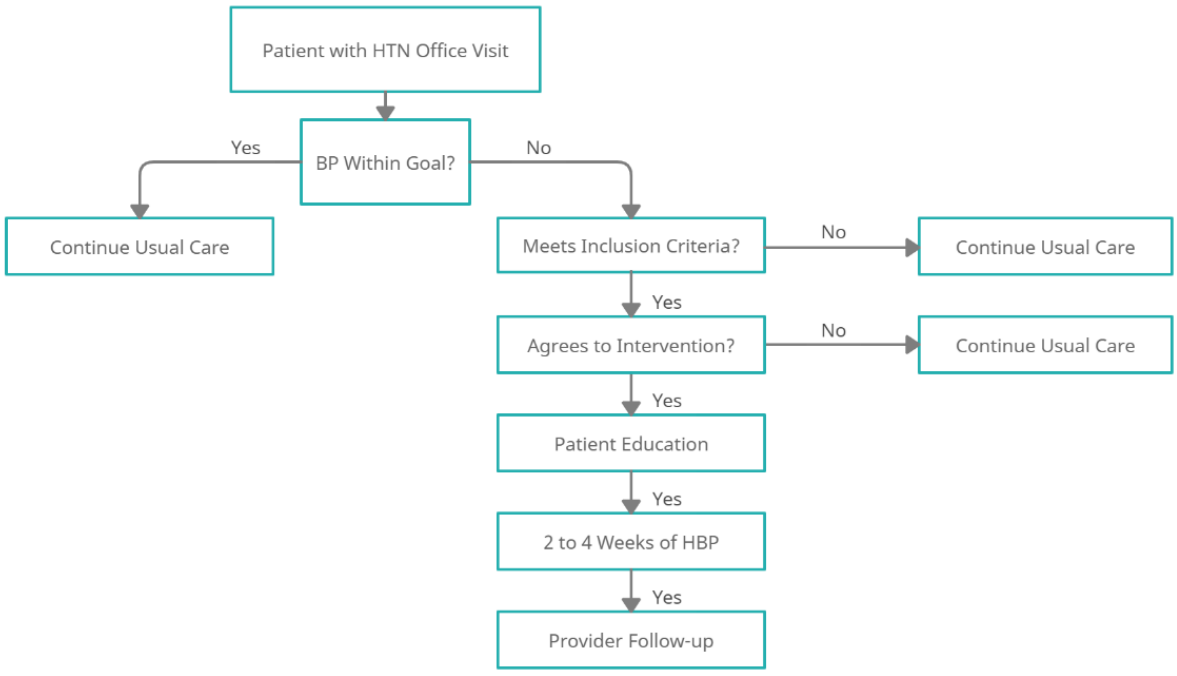


Figure 3

Number of Blood Pressures Logged at 2 and 4 Weeks

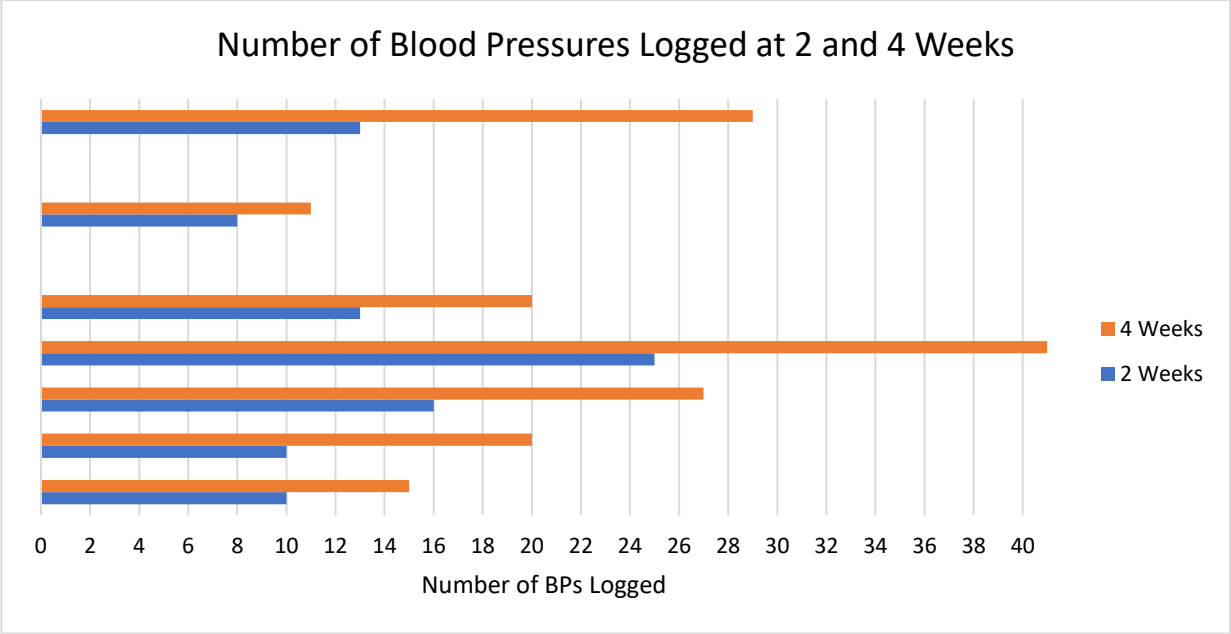


Figure 4

12 Blood Pressures Logged

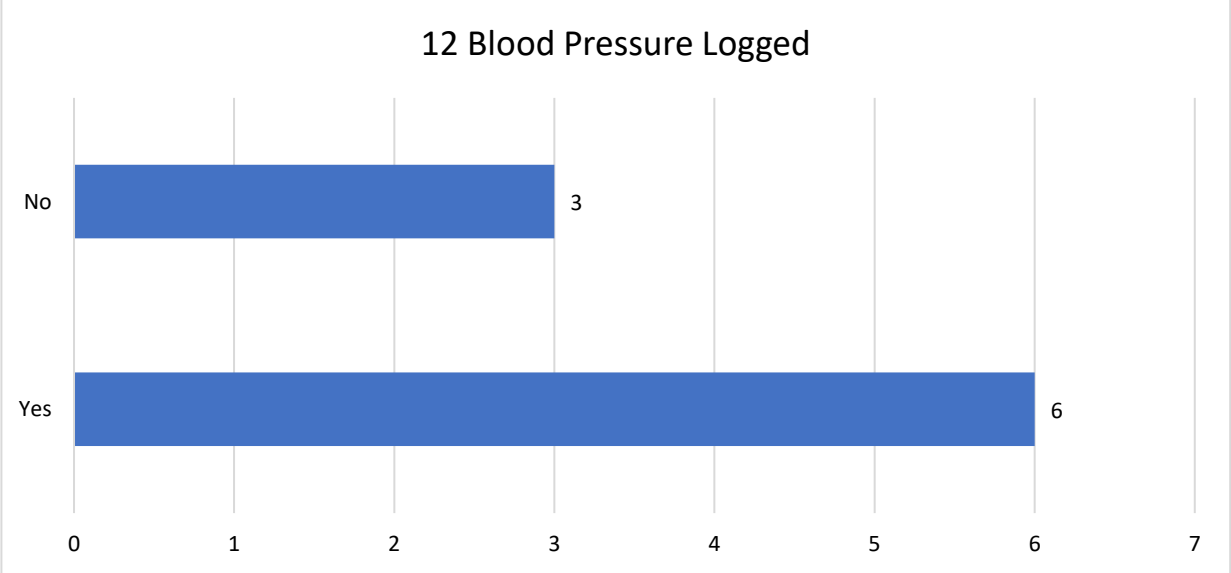


Figure 5

Systolic Blood Pressure

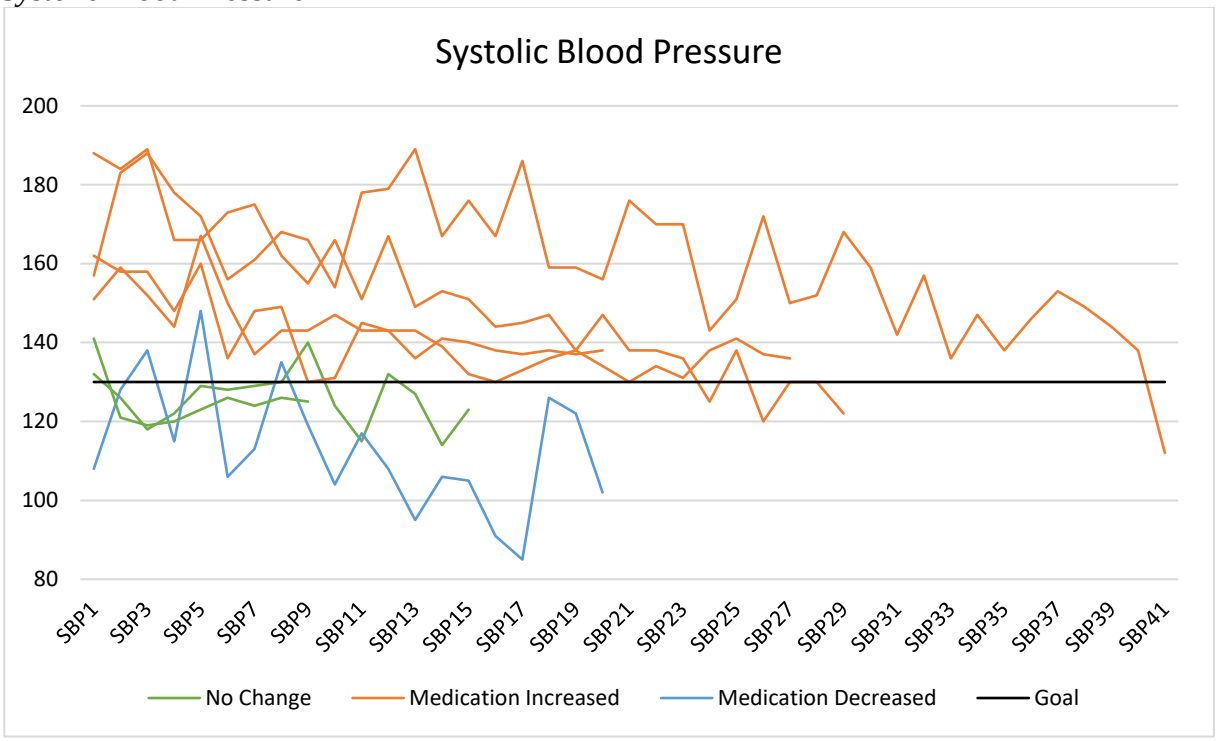


Figure 6

Diastolic Blood Pressure

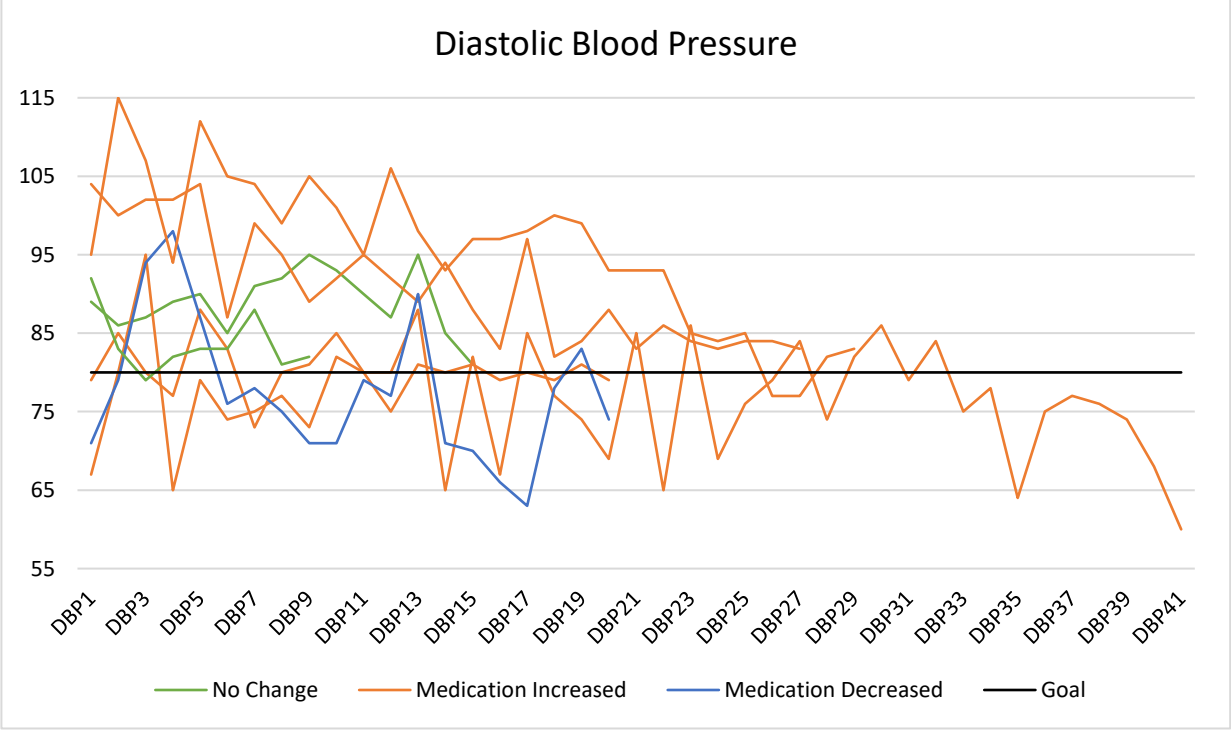


Figure 7

Provider Feedback

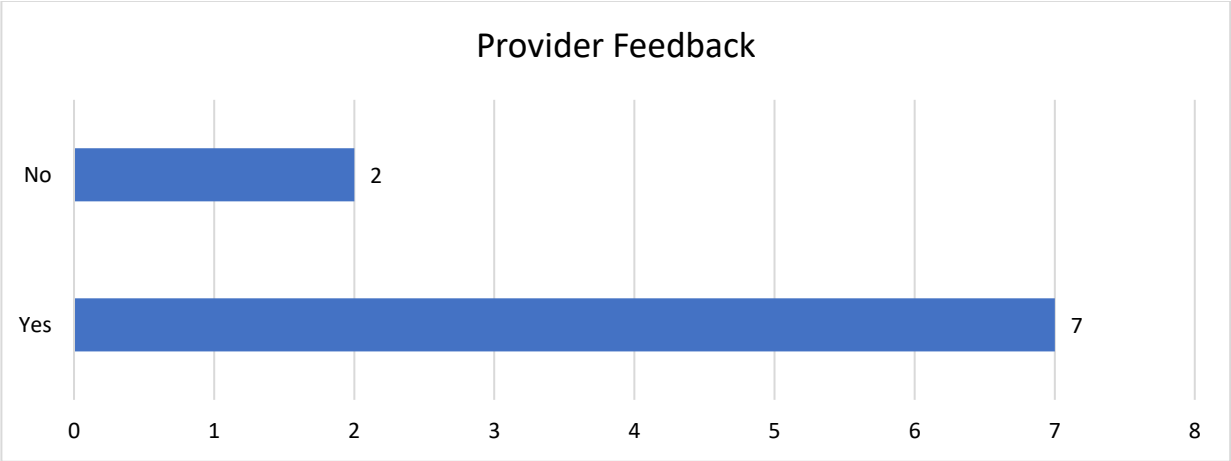
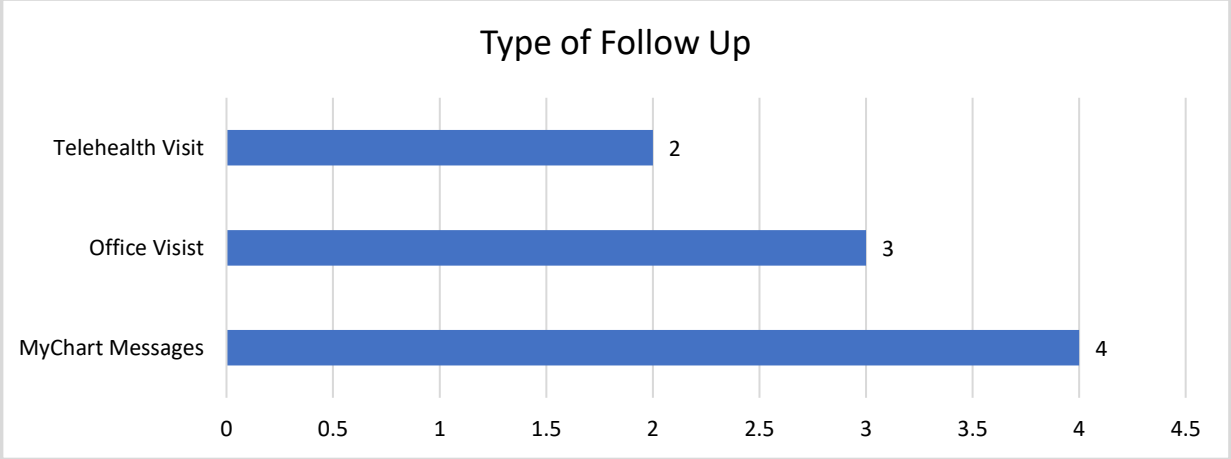


Figure 8

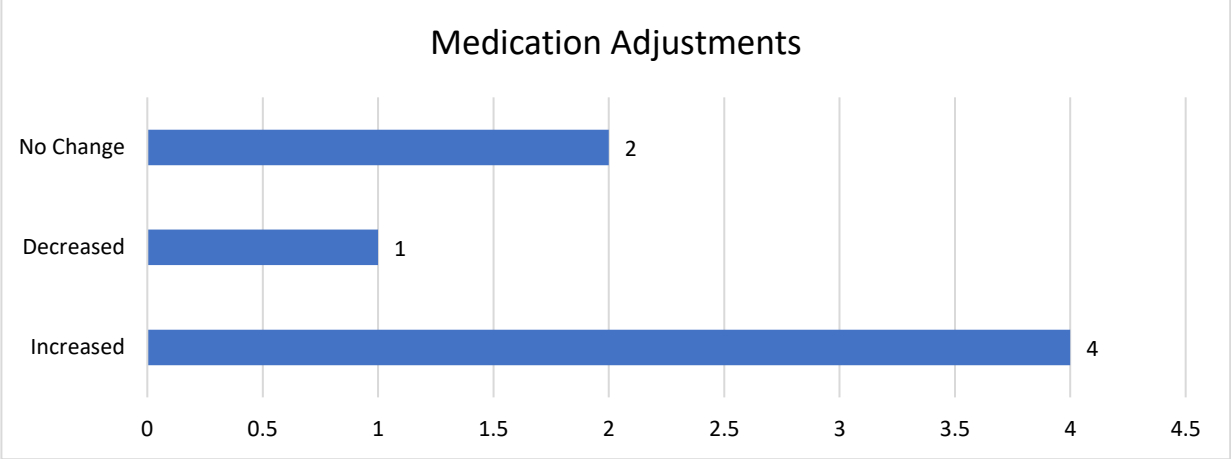
Type of Follow Up



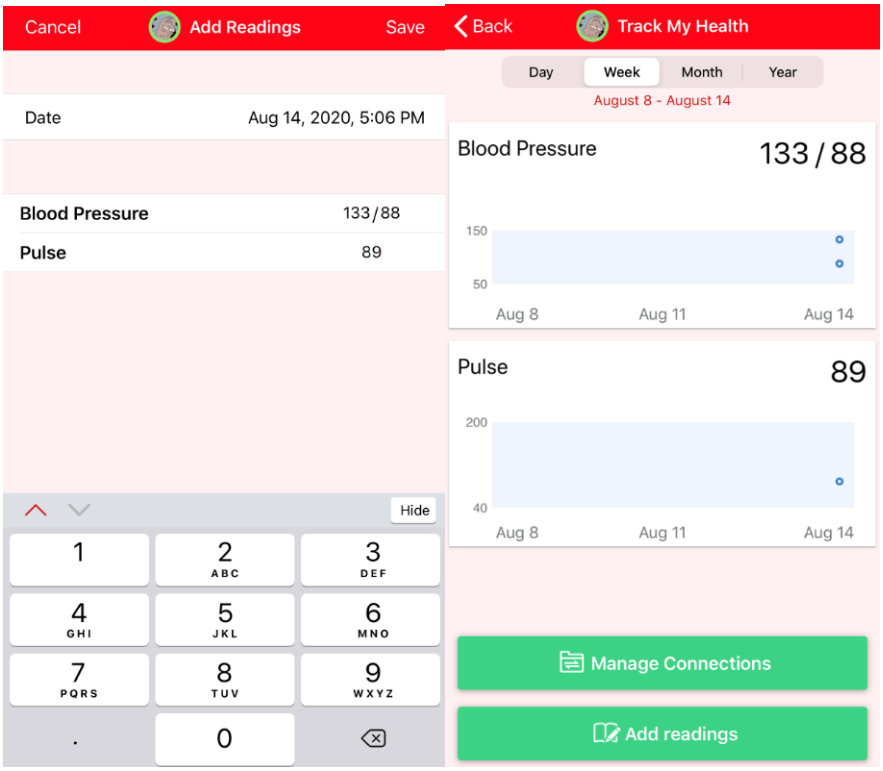
*All types of provider feedback were accounted for including multiple feedback for individual participants

Figure 9

Medication Adjustments



Appendix A



Patient view of logged blood pressure in the mobile MyChart application

Appendix B

Citation: Pan F, Wu H, Liu C, Zhang X, Peng W, Wei X, Gao W. Effects of home telemonitoring on the control of high blood pressure: a randomised control trial in the Fangzhuang Community Health Center, Beijing. Aust J Prim Health. 2018 Nov;24(5):398-403. doi: 10.1071/PY17187. PubMed PMID: 30131099.					
Objectives Evaluate the effect of home blood pressure monitoring with telehealth transmission on the control of high blood pressure	Methods: RCT	Outcomes Average change in BP BP estimates on day 30, 90 and 180	Sample Intervention: n=52 Control: n= 55	Results/Findings -86.5% in the intervention group completed more than 70% of required data transmission. -Medication changes 48.7% vs 12.3% -Greater reduction in blood pressure compared to control -Intervention greater reduction of BP -Higher use of app greater reduction -Increases patient awareness and involvement -Provides the medical team more data increasing medication changes -Improves communication and coordination	Strength/Weaknesses -Small sample size -Not blinded -Potential Hawthorne effect -Long term effect not known
Citation: Buis LR, Roberson DN, Kadri R, Rockey NG, Plegue MA, Danak SU, Guetterman TC, Johnson MG, Choe HM, Richardson CR. Understanding the Feasibility, Acceptability, and Efficacy of a Clinical Pharmacist-led Mobile Approach (BPTrack) to Hypertension Management: Mixed Methods Pilot Study. J Med Internet Res. 2020 Aug 11;22(8):e19882. doi: 10.2196/19882. PubMed PMID: 32780026; PubMed Central PMCID: PMC7448180.					
Objectives Investigate the feasibility, acceptability and preliminary effectiveness of BPTrack (a clinical pharmacist-led intervention that incorporates patient and clinician facing apps to make electronically collected, patient generated data availability to providers in real time for HTN management. App includes medication reminders. -Aimed to understand barriers to adoption and areas for improvement identified by key stakeholders in improve widespread application	Methods: Mixed method pilot study with a 12-week pre post intervention	Outcomes Primary Outcomes: -change in BP -Utilization of the BPTrack app Secondary Outcomes: -change in medication adherence	Sample N=15	Results/Findings -40.1% were fully compliant on days between baseline and follow-up. -After 12 weeks significantly reduce in SBP and DBP -Patient perceived it as effective -Medication reminder did not improve adherence -Patients uploaded at least one blood pressure measurement on 75% of study days -Reduction of SBP and DBP -BPTrack was a feasible option for primary care	Strength/Weaknesses -Requires technology -Small sample size
Citation: Sheppard JP, Tucker KL, Davison WJ, Stevens R, Aekplakorn W, Bosworth HB, Bove A, Earle K, Godwin M, Green BB, Hebert P, Heneghan C, Hill N, Hobbs FDR, Kantola I, Kerry SM, Leiva A, Magid DJ, Mant J, Margolis KL, McKinstry B, McLaughlin MA, McNamara K, Omboni S, Ogedegbe O, Parati G, Varis J, Verberk WJ, Wakefield BJ, McManus RJ. Self-monitoring of Blood Pressure in Patients With Hypertension-Related Multi-morbidity: Systematic Review and Individual Patient Data Meta-analysis. Am J Hypertens. 2020 Mar 13;33(3):243-251. doi: 10.1093/ajh/hpz182. PubMed PMID: 31730171; PubMed Central PMCID: PMC7162426.					

Objectives Examine whether self-monitoring can reduce clinic BP in patients with hyper-tension related co-morbidities	Methods: Systematic review of Medline, Embse and Cochrane Library of self-monitoring of BP were selected and individual patients were requested	Outcomes Primary Outcomes: -Change in clinic BP between baseline and 12 months by number of comorbidities Secondary Outcomes: -likelihood of uncontrolled BP at 12 months by number of comorbidities Outcomes were also accessed at 6 months	Sample 26 trials between 2005-2016 10,713 participants Primary outcomes were available in 16 studies and 7,360 of which 6,522 had completed	Results/Findings Self-monitoring was associated with reduced clinic SBP compared to usual care at 12 month follow up regardless of comorbidities -Intense intervention were more effective than low intensity intervention in patients with obesity a possibly stroke but this effect was not observed in patients with CAD, DM or CKD -Self monitoring was found to be effective at lowering BP regardless of number of comorbidities -cointerventions include self-management, pharmacist support, tailored education and lifestyle counseling	Strength/Weaknesses -Largest IPD meta-analysis of trials examining the efficacy of self-monitoring of BP in HTN patients with a HTN related co-morbidity -Unable to collect data from all related studies
Citation: Morton K, Dennison L, Bradbury K, Band RJ, May C, Raftery J, Little P, McManus RJ, Yardley L. Qualitative process study to explore the perceived burdens and benefits of a digital intervention for self-managing high blood pressure in Primary Care in the UK. BMJ Open. 2018 May 8;8(5):e020843. doi: 10.1136/bmjopen-2017-020843. PubMed PMID: 29739782; PubMed Central PMCID: PMC5942415.					
Objectives Explore perceived burdens and benefits for patients using a digital self-management intervention for reducing high BP Further understand how to best capture burdens and benefits when evaluating health interventions	Methods: Qualitative study	Outcomes Benefits and burdens of home monitoring	Sample N=35	7 Themes 1) Benefit of reassurance from seeing BP readings -Reassurance when BP readings are well controlled -Reassurance from keeping an eye on BP 2) Benefit of motivation for lifestyle change from seeing BP readings -Seeing BP readings motivated lifestyle change 3) Benefit of better health -Perceived health improvement from medication changes -Intervention can facilitate management of side effects 4) Burden of worrying about health -Negative emotional responses to seeing high readings -Worrying about medication change affecting health 5) Burden of uncertainty from self-monitoring -Uncertain about whether readings are representative -Uncertainty about what to do about high or low readings 6) Burden of thinking about making lifestyle changes -Worry or guilty about not engaging with healthy changes 7) Burden of the practicalities of adhering to intervention procedures -Buren of fitting self-monitoring into schedule	Strength/Weaknesses Strengths: -relatively open questions -Wide range of controlled and uncontrolled HTN Limitation: -Repeated interview may have been helpful -Did not assess psychological factors such as reassurance, anxiety or uncertainty
Citation:					

Beran M, Asche SE, Bergdall AR, Crabtree B, Green BB, Groen SE, Klotzle KJ, Michels RD, Nyboer RA, O'Connor PJ, Pawloski PA, Rehrauer DJ, Sperl-Hillen JM, Trower NK, Margolis KL. Key components of success in a randomized trial of blood pressure telemonitoring with medication therapy management pharmacists. J Am Pharm Assoc (2003). 2018 Nov - Dec;58(6):614-621. doi: 10.1016/j.japh.2018.07.001. Epub 2018 Aug 1. PubMed PMID: 30077564; PubMed Central PMCID: PMC6727963.					
Objectives The Hyperlink trial tested a 12-month intervention of home blood pressure telemonitoring with pharmacist case management in adults with uncontrolled hypertension. The intervention resulted in improved BP control compared with usual care at both 6 and 12 months. The aim was to investigate factors contributing to intervention success	Methods: Mixed-methods analysis of process of care data, patient focus groups and pharmacist interviews	Outcomes Mixed-methods analysis of process of care data, patient focus groups and pharmacist interviews	Sample 228 intervention patient of the 450 were examined. 5 patient focus groups and 4 pharmacist interviewed	Results/Findings The original study showed improvement in both SBP and DBP 4 Themes Identified: -Relationship between patient and pharmacist -Individual Treatment plan -Communication between clinical staff -Importance of frequent phone contact with pharmacist BP control was achieved in 3 months in many patients -Key components of the intervention success were use of home monitor and frequent medication changes over the phone -Patient and pharmacist valued strong patient/pharmacist relationship and individualized treatment plans	Strength/Weaknesses not known
Citation: Parker RA, Paterson M, Padfield P, Pinnock H, Hanley J, Hammersley VS, Steventon A, McKinstry B. Are self-reported telemonitored blood pressure readings affected by end-digit preference: a prospective cohort study in Scotland. BMJ Open. 2018 Jan 31;8(1):e019431. doi: 10.1136/bmjopen-2017-019431. PubMed PMID: 29391369; PubMed Central PMCID: PMC5878245.					
Objectives To determine if there was an apparent preference for particular end digits and entries which were just below target BPs which might suggest evidence of data manipulation	Methods: Prospective cohort study	Outcomes Compare BP readings between the patient texts and automatic-transmission systems while taking into account clustering of readings within patients	Sample N1=44,000 BP from 1068 N2= 20,705 BP from 199	Results/Findings Compared with automatic transmission, texted BPs had a significantly higher proportion of occurrences of both SBP and DBP having zero as an ending digit (less than 2%) Preference for SBP 134 and DBP 84 when alert cut off was 135/85 End zero preferences for zero numbers and specific value preferences for readings just below the alert threshold exist among self-reported data. This proportion is small and unlikely to be clinically significant	Strength/Weaknesses Strength: -Large sample size -control group