7-2016

# A Best Practice Guide for the Usage of Mobile Health Applications

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# A BEST PRACTICE GUIDE FOR THE USAGE OF MOBILE HEALTH APPLICATIONS

A Capstone Research Project Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Nursing Practice

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Nursing Practice

July 2016

This Capstone Project by: Laurie Fridley Niles

Entitled: *A Best Practice Guide for the Usage of Mobile Health Applications* has been approved as meeting the requirement for the Degree of Doctor of Nursing Practice in College of Natural and Health Sciences, School of Nursing, Program of Nursing Practice.

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## EXECUTIVE SUMMARY

Niles, Laurie Fridley. *A Best Practice Guide for the Usage of Mobile Health Applications.* Unpublished Doctor of Nursing Practice Capstone Project, University of Northern Colorado, 2016.

The purpose of this capstone was to develop a best practice guide for the use of mobile health applications (mHealth apps) to aid in the care of chronically ill patients using an exemplar of blood pressure (BP) tracking for hypertension (HTN). Research on the use of mHealth apps is growing but a best practice guide for deployment of the apps has not yet been developed. Mobile health apps have expanded rapidly as smartphone technology captured the attention of American society. Mobile health apps have both inherent benefits and risks. The primary benefit of mHealth apps is the ability to track and display data at regular intervals during the day without resorting to paper data collection. The primary risk of mHealth apps is the possible violation of Health Insurance Portability and Accountability Act (HIPAA) laws with technology that is not yet adequately regulated by appropriate authorities.

Mobile health technology on smartphones has proven to be far more useful than simply a replacement of paper data collection. Data show the use of smartphones for tracking data such as BP measurements engages patients in their treatment plans and empowers them to advocate for themselves. This empowerment adds a new dimension to the patient-provider relationship and to treatment plans, and one that providers should

embrace. Smartphones give patients concrete actions to perform, promoting adherence to treatment plans and activities that foster long-term health.

Although smartphone technology is mature and widespread, the healthcare community had not fully exploited it in an effort to combat chronic illnesses. This capstone focused on the development of a best practice guide for the usage of mHealth apps in an effort to facilitate deployment of mHealth apps in clinical settings. It was meant to serve as a practical best practice guide for healthcare providers to understand the capabilities of mHealth apps in the effort to reduce the effects of chronic illnesses in the United States and the benefits and risks associated with the use of mHealth apps. It was also meant to serve as a "How-To" book for the deployment of mHealth apps to patients with chronic illnesses.

## ACKNOWLEDGEMENTS

I could never have finished this journey without the help of many people. Their support, counsel, and guidance are deeply appreciated.

First and foremost, I would like to thank my family. I would like to thank my husband, one of the most intelligent people I know, who never let me doubt my abilities and was always there with his calm reassurance and guidance. I never would have started without his love and strength. I would like to thank my children, Gareth and Olivia, who were always supportive of my decision and never doubted me. They took the brunt of my education when I was not able to cook or play with them. I would like to express my gratitude to my mother, my greatest cheerleader, who has always told me to fight for I what I want. She always has. She has been an important role model during my life. I would like to thank my sister, Kathy, who has been an extremely important role model in my life. I have always looked up to her and valued her opinions. Whenever I have come to a crossroad, I have tried to take the path I thought Kathy would have taken. On the days I was ready to quit, I would call Kathy who could always motivate me to persist. Kathy is very important to me and there will never be words to express this sentiment. I would like to thank her for always giving me the many words of encouragement that steered me through the hard times. Finally, I would also like to thank my brother, Michael, for his support and encouragement. His strength has always been able to keep the family together and secure. He is an amazing person.

Second, I would like to express my sincerest gratitude to my committee members: Dr. Rhonda Squires, Dr. Michaela Romero, and Dr. Katherine Sullivan for assistance with this capstone. I would like to give special thanks to Rhonda for her patience and persistence in reading this manuscript and making many suggestions that enabled it to become what it is today.

Finally, I appreciate my friendship with my co-conspirator, Tracy Nunnally. Having him in class made the journey so much easier. I am honored and privileged to have him as a colleague and friend. I would like to thank all these people for giving me the opportunity to reach my goal--Doctor of Nursing Practice!

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## DEFINITIONS AND ACRONYMS

| | |
|---|---|
| Apps | Applications for use on smartphones. |
| ABPM | Ambulatory blood pressure monitoring |
| APRN | Advanced Practice Registered Nurse |
| BP | Blood Pressure |
| CDC | Centers for Disease Control and Prevention |
| DNP | Doctor of Nursing Practice |
| EDC | Electronic data collection |
| Elderly | People defined as 65 years and older. |
| Hacker | Person who uses computers to gain unauthorized access to data. |
| HBPM | Home blood pressure monitoring |
| HIPAA | Health Insurance Portability and Accountability Act |
| HTN | Hypertension |
| MeSH | Medical Subject Headings |
| mHealth apps | Mobile health applications, a term coined for the practice of health care and wellness supported by mobile devices. |
| Millennials | People born between early 1980s to the early 2000s. (also known as the Millennial Generation or Generation Y) |
| PDC | Paper data collection |

| | |
|---|---|
| Smartphone | Mobile phone capable of downloading and running mobile phone apps |
| Trialability | The ease of use of an innovation |
| Widget | Standard term in computer programming to describe a component to a graphical user interface that provides a function or enables a service |

# CHAPTER I

# PROBLEM STATEMENT

## Background and Significance of Mobile Health Apps

Despite the prevalence of smartphones and their applications, very little professional documentation and regulations exist for the use of smartphone health applications (mHealth apps) in the healthcare arena. "There is an app for that" is a common phrase that pervades American pop-culture. That short phrase has a fast and astounding history behind it. Apps are software for mobile computers that can be downloaded from repositories known as "app stores." Usage of apps requires ownership of mobile computers such as laptops, tablets, or smartphones that evolved from early computers called "main-frames." These large machines occupied entire rooms and required computer experts to manage, maintain, and decipher cryptic commands (Sena & Sena, 2013). Personal computers evolved as accessible machines for ordinary people and established a need for connectivity to other computers, which in turn enabled mobile computing, a need for smaller computers, and finally a need for apps.

Sena and Sena (2013) showed the tablet evolved from the personal computer and took on many forms still in use today. As applications became more effective, the computer and its derivative, the smartphone, became dominating forms of communication for the masses. These machines are now at the heart of many communication channels. The Pew Research Center (2012) conducted a three-month

survey in the United States and reported that 85% of adults own smartphones, most of them being smartphones capable of running mHealth apps.

Nielsen (2014) reported that 171.5 million U.S. citizens or 71% own a mobile or smart phone, herein only noted as smartphones. Smartphones are essential in daily life for many of these users. "While age plays a role in smartphone ownership, this technology doesn't have a gender divide" (Nielsen, 2014, p. 1). According to Nielsen (2014), 70% of men and 72% of women own these devices.

Mobile computing and app usage are not confined to a particular generation or genre. Apps can be designed for serious uses such as online banking, email review, and automobile navigation or for simple amusement and time passage. The healthcare community participates in mobile computing through mHealth, an ever expanding technology sector being used in clinics around the world (mHealth Summit, 2015). The mHealth Summit is part of a larger organization called the Health Information and Management System Society (HIMSS; 2016). The HIMSS supports three summits associated with mobile healthcare solutions, cybersecurity, and population health.

The Pew Research Center (2012) estimated 31% of those adults used their smartphones to search for mHealth apps. Kratzke and Cox (2012) reported the fastest growing age sector using mHealth apps in the year 2011 was 55-64 years old with a growth of 17-30%, arguing that the number of smartphones would soon outnumber the number of personal computers. Mobile health apps on smartphones can be used for many chronic illnesses. A study conducted by Krebs and Duncan (2015) noted more than half of smartphone users had downloaded mHealth apps and used the app at least once per day. For instance, Tran, Tran, and White (2012) reviewed many glucose monitoring

applications and discussed the success of diabetes management with glucose control. “Consistent self-monitoring blood glucose (SMBG) has been shown to be a useful tool in improving glycemic control in type 2 diabetes” (Tran et al., 2012, p. 173).

Goh et al. (2015) studied the use of mHealth apps with diabetes mellitus type 2. The primary purpose of the mHealth apps used in this study was to log diet and exercise. An interesting observation was diet and glucose tracking, the ostensible purpose of the mHealth apps, was not the primary value of the apps. The greatest impact stemmed from improved patient adherence and involvement with mHealth apps usage. Self-tracking of glucose using mHealth apps improved patient adherence and involvement.

Goh et al. (2015) were not blind to the obvious extension to other chronic illnesses, concluding mHealth apps could become standardized tools for use with patients with all chronic illnesses. The primary mechanism for improved quality care was not extensive data collection but rather improved patient engagement. One way to understand this mechanism is to cast it into the middle-range theory of self-care of chronic illness (MRTScCI) formulated by Riegel, Jaarsma, and Stroemberg (2012). This theory codifies self-care of chronic illness into three activities: self-care maintenance, self-care monitoring, and self-care management. Mobile health apps fit cleanly into self-care monitoring since patients can use mHealth apps to collect better data about their chronic illnesses.

A distinction must be made between data measurement and data collection to understand the activities involved in self-care monitoring with respect to smartphones. The present state of the technology enables smartphones to function as recording devices but not measurement devices. Smartphones do not have sensors to enable measurements

of any significance and accuracy. Present day smartphones are computers designed for recording data and transmitting data to remote storage devices. Within the confines of the MRTScCI, the ability to collect and to record data on smartphones facilitates patient engagement, enhances self-care monitoring, and improves patient treatment plans.

## Blood Pressure Tracking as an Exemplar for Mobile Health Apps

Blood pressure (BP) tracking for patients with hypertension (HTN) is an excellent exemplar of self-care monitoring via mHealth apps for chronic illness. Due to the prevalence of HTN in the United States and its contribution to myocardial infarctions, aneurysm, stroke, and heart failure, widespread implementation of mHealth apps for HTN patients might significantly decrease the occurrence of acute medical events. The National Institute of Health (NIH; 2015) defined high blood pressure (BP) as systolic BP $\geq$ 140mmHg and diastolic $\geq$ 80mmHg. The Centers for Disease Control and Prevention (CDC; 2015) reported that one of three or 70 million American adults have HTN. Decades of research in HTN has clearly shown poor control increases the risk of cerebrovascular or cardiovascular diseases (CVD). The Eighth Joint National Committee (JNC 8) of the National Heart, Lung, and Blood Institute (NHLBI) has published the seminal guide on treatment thresholds, goals, and medications for patients diagnosed with HTN (James et al., 2014). Evidence collected by the JNC 8 shows even small decreases in BP have noticeable impacts on acute health events in patients.

Blood pressure tracking on mHealth apps adds two dimensions to the efforts to decrease BP to mitigate the prevalence of acute health events related to HTN. For the first dimension, it facilitates the creation of a comprehensive picture of a patient's blood pressure. Home-based BP tracking using mHealth apps can augment clinical

measurements. Isolated clinical measurements can be affected by short-term stress, recent caffeine or nicotine consumption, physical activity, pain, and other factors. Clinical BP measurements do not provide any data for the patient under normal home conditions that might more accurately reflect the patient's true status of controlled or uncontrolled BP. Clinical measurements are infrequent and can have numerous false readings due to recent lifestyle events such as coffee consumption. According to the U.S. Preventive Services Task Force (USPSTF; 2015), a common source of false clinical readings is the "white coat" effect, whereby patients experience anxiety from the presence of healthcare professionals. The USPSTF research has shown 15% to 30% of patients have significantly lower BP at home than at the clinic.

For the second dimension, BP tracking on mHealth apps promotes patient engagement in self-care monitoring activities, empowering them to be champions in their effort for wellness. Hallberg, Ranerup, and Kjellgren (2015) reported one reason hypertensive patients have poor motivation for protocol adherence is they are asymptomatic. "The impact of symptoms on the motivation to follow a hypertension treatment regimen has been pointed out in recent research" (Hallberg et al., 2015, p. 19). In lieu of HTN symptoms, visualization of changes in BP can serve to inspire compliance with HTN treatment. Patients have been able to have BP measured at numerous places such as pharmacies and work-based health offices but then would need to resort to paper data collection (PDC). Mobile health apps add an engaging method to record and display data for future evaluation. Hallberg et al. further explained that a stronger relationship with the healthcare provider and an active role for the patients substantially improves

care. They concluded self-tracking is a useful complement to care and is likely to lead a decrease in CVD events and mortality (Hallberg et al., 2015).

This capstone explored the use of mHealth apps for the self-care monitoring of chronic illnesses using HTN as an exemplar. Hypertension was a natural choice of focus since 30% of Americans have HTN and it lent itself to easy self-monitoring via BP tracking. The technology, mHealth apps, is relatively available and inexpensive. Why are mHealth apps in the healthcare arena lagging behind other technology? What appears to be missing is a best practice guide for mHealth apps use and clinical providers to promote the technology. For this capstone, "best practice" was defined as a strategy for selecting and using mHealth apps, whereby a clinical provider methodically researches, reviews, and assesses the most up-to-date literature on mobile apps in an effort to align patients with optimal wellness plans. It was anticipated that a best practice guide for use of mHealth apps could spark interest and increase usage for both providers and patients.

The implementation of a best practice guide fit squarely in the realm of Doctor of Nursing Practice (DNP) nursing (Waldrop, Caruso, Fuchs, & Hypes, 2014). To transform mHealth apps from obscurity to prominence requires a healthcare provider such as a DNP to create the way by promoting the usefulness of mHealth apps. A step toward prominence was the creation of a best practice guide. With continued maturity of the mHealth technology and the creation of a best practice guide, clinical providers could optimize wellness plans for chronically ill patients by seriously recommending "an app for that."

## Financial Impact

The financial impact of all chronic illnesses on society is great; however, a complete analysis of it was beyond the scope of this capstone. To narrow the financial burden discussion, HTN was used as the example of a chronic illness. At the time of the literature search, no research was reported to establish the savings implementation of mHealth apps on HTN costs. What has been researched is the financial burden of HTN on society; an analysis of this burden could provide an estimate of the possible financial implications of mHealth apps.

Heidenreich et al. (2011) reported the financial burden of cardiovascular disease (CVD) related to HTN within the years of 2010 and 2030 will triple from $272.5 billion to $818.1 billion. Those authors also reported HTN had a larger cost associated with it than CVD because of its preponderance. "Annual costs directly attributable to hypertension are projected to increase $130.4 billion in 2030 compared with 2010, for a total projected annual cost of $200.3 billion by 2030" (Heidenreich et al., 2011, p. 935). As Heidenreich et al. stated, adding to the costs of HTN care are the sequelae to HTN, such as strokes, which when added to the annual financial burden assigned to HTN increases to $389 billion. The CDC (2015) reported HTN costs the nation $46 billion each year due to missing work, medications, and clinical services.

The Colorado Department of Health (CDH; 2013) tabulated facts gathered from the CDC (2015) and the American Heart (2014) Association of the most recent data regarding HTN in the Colorado population. The information reported was a lower limit to the true statistics since many people who are unaware of their HTN were not counted in the final tally. The financial impact collectively for the state of Colorado was $4.4

billion according to the CDH. The CDH also reported HTN varied by poverty level with the greatest rate of HTN correlating with the highest poverty levels. Larimer County did not report local statistics.

The USPSTF (2015) wrote that HTN affected 29.1% of U.S. adults in 2011 to 2012. As the population age increases, so does the prevalence of the disease--7.3% aged 18 to 39 years, 32.4% aged 40 to 59 years, and 65.0% aged 60 years or greater. Ethnicity has a huge impact in the United States with non-Hispanic Black adults having the greatest burden at 42.1% versus Caucasian adults at 28.0%, Hispanic adults at 26.0%, and Asian adults at 24.7% according to USPSTF (2015). Mortality due to HTN was greater than 360,000 of Americans in 2013 according to the CDC (2015).

The CDC (2015) report stated that since an average of 1 out of 5 adults have HTN but are unaware of it, the numbers under-reported the prevalence of HTN. According to the CDC, Colorado is one of the states with the lowest proportion of the population diagnosed with HTN but the numbers are still significant with 25 to 27% of residents having HTN. According to the CDH (2013), heart disease is the second leading cause of mortality with stroke being the fifth in Colorado. Hypertension was the 17th leading cause of death with five in 100,000 deaths in 2013. Hospital discharges for patients with HTN numbered 2,709 per 100,000 people. The CDH also reported the hospital discharge rate for HTN varied by 704 to 5,315 per 100,000 of Colorado residents and the death rate varied from 6 to 99 per 100,000 Colorado residents.

Mobile health apps have now become a ubiquitous part of American life. Americans almost always have a smartphone in hand to capture, record, or display events. According to Patrick, Griswold, Raab, and Intill (2008), mHealth apps were

formerly used by only the millennial generation--born from 1980s to 2000s. Social media have now encouraged the use of mHealth apps in all ages. "Within the next 8 years, annual U.S. expenditure on health care is projected to reach $4 trillion/ year, or 20% of the gross domestic product" (Patrick et al., 2008, p. 177). Patrick et al. also reported there were 239 million smartphone users in the United States. Mobile health apps could add a new dimension to the healthcare community's struggle to mitigate the effects of chronic illnesses on American society.

## Theoretical Frameworks

Two theories provided the framework to support this capstone project. The first theory was the middle-range theory of self-care of chronic illness (MRTScCI; Riegel et al., 2012). This theory provided a nursing-based framework for understanding "why" mHealth apps have the potential for improving self-care of chronic illnesses. "Why" addressed the following healthcare question: Why does implementation promote improved healthcare of patients with chronic illnesses? The second theory was the diffusion of innovation theory (Rogers, 2003). This theory provided a social-based framework for understanding "how" mHealth apps entered into clinical practice. "How" addressed the following social question: How does the healthcare community implement improved healthcare of patients with chronic illnesses through mHealth apps?

### Middle Range Theory of Self-Care of Chronic Illness

The MRTScCI was chosen to answer the "why" of mHealth apps since it is a nursing-based theory codifying why mHealth apps can improve healthcare of the chronically ill. It codifies self-care into two key processes and three foundational pillars. The two key processes are the abilities of patients to make rational decisions and to

reflect on the outcomes of those decisions when taking corrective measures into future rational decisions. These two processes are required for patients to execute self-care and advocate for their treatment plans. The three foundational pillars are termed self-care maintenance, self-care monitoring, and self-care management. According to Riegel et al. (2012), these three pillars work in a cyclical fashion--with the patients and providers stepping through each in sequence and then looping around to the beginning.

Self-maintenance refers to action--the collection of daily activities patients perform to ensure health and wellness. For example, BP control for patients with HTN requires adherence to a healthy diet, maintenance of proper weight, exercise, avoidance of stress, and relaxation among other acts. Maintenance of BP frequently includes taking an antihypertensive medication without reminders from the provider.

Self-care monitoring involves reflection on the outcomes of the self-care maintenance acts. For patients with HTN, self-care monitoring is primarily about teaching patients to understand how they feel in connection with self-maintenance acts. This pillar is strong for many chronic illnesses but relatively weak since HTN can be asymptomatic and patients are commonly unaware of rising BP. The USPSTF (2015) wrote,

> Uncontrolled hypertension is a risk factor for heart attack, stroke and congestive heart failure and a major contributing factor to CVD and all-cause mortality in the United States. Persons with high blood pressure often have no signs or symptoms of the condition; however, once diagnosed, it is usually amenable to treatment. (p. 782)

Hallberg et al. (2015) reported, “The impact of symptoms on the motivation to follow hypertension treatment regimen has been pointed out in recent research,” claiming that one reason hypertensive patients have poor motivation for protocol adherence is they

fail to recognize their symptoms. Adding BP tracking with mHealth apps could greatly improve self-care monitoring by providing quantitative feedback for reflection, enabling the patient to understand the outcomes of self-care maintenance activities.

Self-care management is the art of decision making and requires more involvement from the provider. It is the process of making decisions about future self-care maintenance acts based on reflection performed during self-care monitoring. In many chronic illnesses, this pillar is the weakest of the three and varies greatly with the intelligence and engagement of patients. According to Riegel et al. (2012), by design, self-care management should be the weakest of the three and should require more professional intervention.

**Diffusion of Innovation Theory**

The diffusion of innovation (DOI; Rogers, 2003) theory was chosen to answer the "how" for mHealth apps since it is a social-based theory codifying how mHealth apps can diffuse into standard practice to aid in the treatment of chronic illnesses. According to Rogers (2003), inventions change the behaviors of people: "Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system" (p. 12). The DOI theory for mHealth apps might be applied on the patient level--where providers diffuse the technology to patients or on a clinic level--where innovators diffuse the technology to clinics.

The DOI theory is sometimes described with five key elements and sometimes with four key elements. According to Rogers (2003), the five elements of the five-element description are the attributes of the innovation, the type of decision, the communication channels, the social systems, and the change agent. The variant with four

elements ignores the type of decision. According to DOI theory, the change occurs due to reasons for expansion of the innovation and the importance of the innovation to the social system. The DOI theory provided a framework for understanding the adoption of mHealth apps in clinical settings and the function of a best practice guide to act as a change agent to promote adoption.

The DOI theory has been applied to evolution of high-technology devices from computers to portable tablets (Sena & Sena, 2013). In the early days, the personal computer was a device only for a small group of technically savvy people. Sena and Sena (2013) showed the tablet evolved from the personal computer and tablets took on many forms still in use today. As applications became more effective, the computer and its derivatives, the tablet and the smartphone, became the dominant form of communication for the masses and are now at the heart of nearly all communication channels.

The expected number of clinics adopting an innovation as of function of time, i.e. the rate of adoption, follows a Bell curve--beginning with a small number of adopters, growing to a peak, and then declining again. This curve, shown in Figure 1, is one of the basic tenets of DOI theory. The only adopters in the very early stages of the lifecycle of mHealth apps are the few clinical innovators who find a need and learn how to use it despite there being very few clinic providers available for comparison. The second group of adopters is clinical providers who are fairly savvy about mHealth apps and are willing to climb a learning curve to access the innovation. The early majority has the advantage of learning from the early adopters and innovators and the late adopters are people who adopt the mHealth apps only after they have widespread acceptance. The final group of

clinics is the laggards who are often coerced into a technology that has become the norm and not using it has left them at a disadvantage.

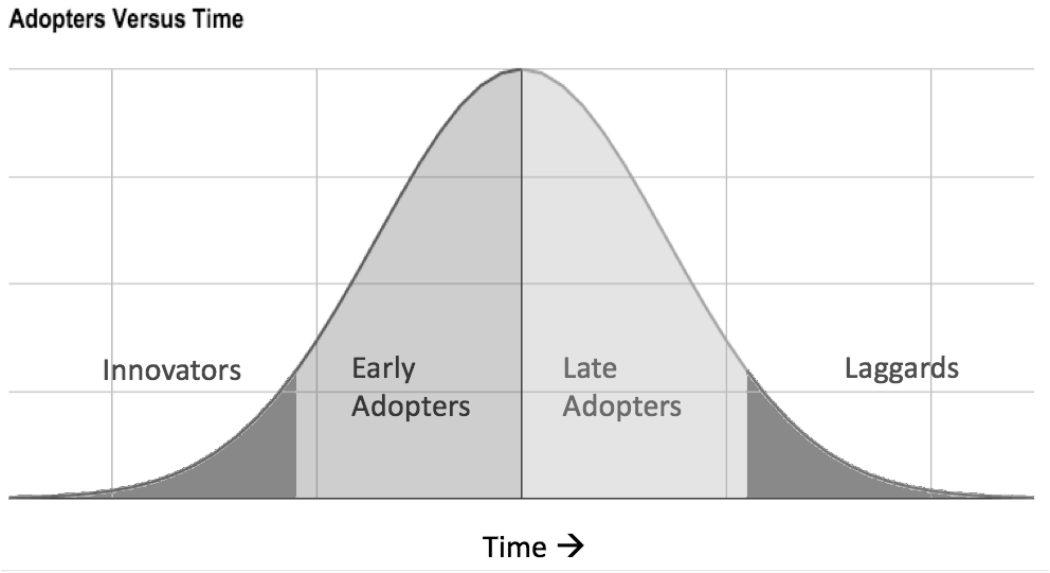


*Figure 1.* Adoption of an innovation as a function of time.

The first input element of the five-component DOI theory is the innovation itself. The innovation has five characteristics associated with it: the relative advantage of the innovation, the compatibility of the innovation within the social network, the complexity of the innovation, the trialability of the innovation, and the observability of the innovation. A best practice guide with regard to mHealth apps must incorporate these five characteristics of DOI theory.

Relative advantage of the innovation refers to a comparison of the using mHealth apps for electronic data collection (EDC), e.g., BP tracking versus using paper data collection (PDC; Walther et al., 2011). Displays enable patients and providers to view data quickly in either numerical or graphical outputs. Data review is simple with either

chart display or tabular display. Paper data collection might be a convenient way to record data but it offers little in terms of graphical display. Information should only display BP measurements, date, time, and possible comments if so desired. Comments could be what was happening at the time of measurement. The mHealth app must remain simple to avoid complexity, prevent confusion, and retain its relative advantage over PDC.

Compatibility of the innovation within the social network refers to the acceptance of mHealth apps within the target population, which might be healthcare clinics. Kratzke and Cox (2012) showed that people between 54 and 64 years were the fastest growing demographic adopting smartphone technology. Their work showed age was not a fundamental barrier to clinical adoption of mHealth apps. Mobile health apps are highly compatible with modern day social networks regardless of age or economic status, income level, and educational level. These facts should be a fundamental driving force to encourage clinics to adopt mHealth apps for patients with chronic illnesses.

Complexity of the innovation refers to the ability to make effective use of mHealth apps with minimal training. The research of Cocosila and Archer (2005) clearly showed best practice means a very simple mHealth app void of extraneous features. Many mHealth apps incorporate simplicity as a fundamental design feature. An experienced DNP user could explain these features to encourage adoption of the technology.

Trialability of the innovation refers to the costs associated with trying the mHealth apps before deciding to incorporate it into daily life; data showed users do not want to pay for mHealth apps (Krebs & Duncan, 2015). It is a social norm and common

practice not to pay for mHealth apps. Another common practice is a free version of the app with limited capabilities and access to extended features with a nominal payment. Free mHealth apps are common. Many mHealth apps do not mandate payment but simply suggest a nominal contribution to help cover the costs of creation. A best practice guide should include choosing an mHealth apps that does not cost the clinic or the patient money but has, at most, a nominal fee structure.

Observability of the innovation refers to the ability to watch someone else use the mHealth app to understand its capabilities. Clinical staff would act as their own agents to observe the capabilities of mHealth apps. Clinical staff must also understand best practice for patient usage cannot incorporate observability by connecting a patient with other patients. Instead, the clinical provider must provide observability by showing the mHealth app directly to patients.

The second input element of the DOI theory affecting the rate of adoption is the type of decision. Decisions may be optional--innovations that do not have alternatives are more likely to be non-optional. Decisions may be authoritative--the USPSTF (2015) could stipulate adherence to their standards of care required BP tracking mHealth apps for patients with HTN. Decisions may be collective or individual--a collective decision is one that requires a group of people to jointly decide to adopt or decline. Individual-optional decision processes tend to be quick. Collective or organizational decision processes are those that require many people of an organization to come to a consensus. Since consensus building can be a time-consuming process, collective innovation processes tend to be slow. An authoritative decision-process adds the element of an authority retaining the final right to adopt an innovation for a collective.

The third input element of DOI theory is a set of communication channels jointly described as “a process in which participants create and share information with one another in order to reach a mutual understanding” (Rogers, 2003, p. 5). Communication channels are collectively referred to as the method of diffusion (Rogers, 2003). Primary communication in this capstone project was face-to-face conversions between the DNP candidate and staff members of healthcare clinics. Health Insurance Portability and Accountability Act (HIPAA; 1996) laws prevent providers from connecting patients to social networks. The DNP candidate explained the prevailing communication channel for mHealth apps dissemination was between the provider and patients with chronic illnesses. Patient to patient communication could only be through channels external to the clinical setting and was not promoted as best practice. Intra-patient communication was certain to occur but would not be promoted at the clinical level.

The fourth input element of the DOI theory is the social network associated with mHealth apps. Smartphones have nearly complete penetration within the United States, meaning all Americans who want smartphones have smartphones. Technically astute patients are more apt to adopt technical innovations over less technically astute patients. Social subsystems such as religious groups that shun technology are not amenable to mHealth apps.

The fifth and final element of the DOI theory is simply time. All innovations take some time to adopt. However, the overall time of adoption can be compressed by promotional actions such as the DNP candidate presenting to a group of volunteer providers. A best practice guide could shorten the time for adoption by providing a

concise source of information targeted specifically to clinicians and instructing them on mHealth app selection and use conditions.

The attributes of the innovation, the decision type, the communication channels, and the characteristics of the social system work together to influence the time required for adoption of an innovation. The rate of app adoption has been fast in many industries, e.g., banking and social media. In those cases, the first three components did not present severe barriers to implementation. In the healthcare arena, HIPAA (1996) laws present steep barriers within communication channels that thwart rapid implementation. Furthermore, the potential for law suits associated with poorly conceived wellness plans presents a barrier within the social system, further thwarting rapid implementation.

The five input elements of DOI theory work together in a decision-making process for the adoption of an innovation, shown schematically in Figure 2. The first phase of the decision-making process—knowledge--has largely been done for mHealth apps since a majority of people have working knowledge of mHealth apps and understand at least in principle that mHealth apps exist. The second phase—persuasion--is where the best practice guide describes the value of the mHealth apps to the clinics and how they can help aid clinical providers in a treatment plan. During the persuasion phase, the best practice guide must describe the five previously mentioned attributes of the innovation to encourage clinical staff to adopt the technology. The third phase—decision--is a yes/no step where clinical providers must decide to either use or discard mHealth technology. The fourth phase—implementation--is where clinical providers must adopt the innovation and learn how to use it to aid in the treatment plan of patients with chronic illnesses. The fifth and final phase—confirmation—is where clinical

providers decide to either continue using an mHealth app that was adopted or decide to discontinue using an mHealth app due to new information.

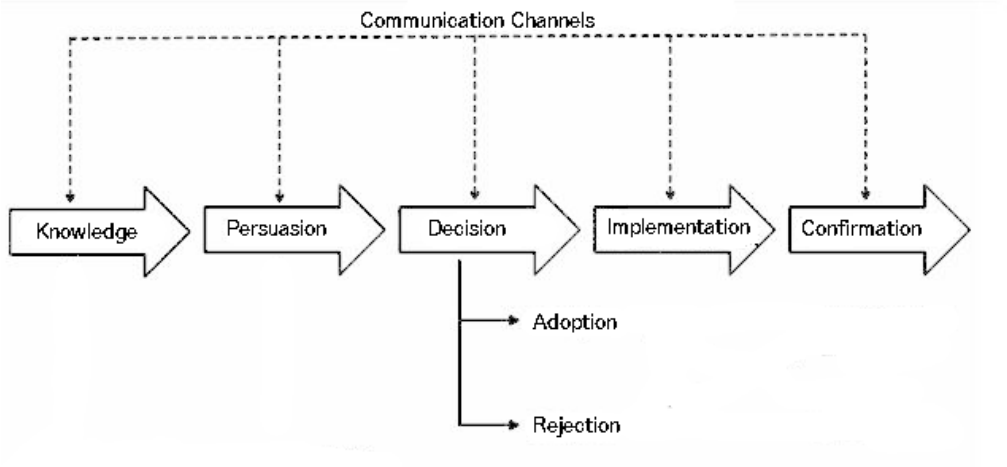


*Figure 2.* The five stages of the decision-making process.

## Needs Assessment

A best practice guide for the purpose of this capstone was previously defined as a strategy for selecting and using mHealth apps to optimize treatment plans for patients with chronic illnesses. The purpose of this project was to develop a best practice guide for the use mHealth apps using HTN as the exemplar chronic illness. As technology improves on mHealth apps, the need to integrate a best practice guide also increases.

To date, a thorough search of the literature did not yield a best practice guide for mHealth apps. Rogers's (2003) DOI theory was used to devise a best practice guide for the use of mHealth apps in a clinical setting. The DOI theory is an effective framework for incorporating technology. For the provider, mHealth apps are readily available on the open market and society has accepted them. For the patient, it is virtually the same

scenario. Bringing mHealth apps into care treatment must accompany a best practice guide to minimize harm and maximize benefits.

## Summary

It is certain mHealth app use for chronic illnesses will only increase in the future with or without the involvement of clinical providers. Diffusion of mHealth app technology without the involvement of clinical providers is problematic. First, it empowers patients while simultaneously disempowering providers who do not embrace new technology. A patient could legitimately question the value of the provider if the provider has only clinical data and the patient has that same clinical data and a wealth of ordinary-life data. Second, it exposes patients to risk if patients choose mHealth apps unwisely, use the recorded information unwisely, or fail to understand the consequences of violating HIPAA (1996) laws. Within the language of DOI theory, providers need to be early adopters of mHealth app technology and not relegate themselves to the status of "laggards." The best way to avoid being labeled laggards in the treatment of chronic illnesses is to develop a best practice guide for the use of mHealth apps.

# CHAPTER II

# PROJECT DESCRIPTION

## Literature Review Parameters

Multiple databases were mined for a thorough and systematic search of available literature on mHealth apps use in chronic illnesses. To develop a broad picture for the overall use of mHealth apps, multiple chronic conditions such as hypertension, diabetes, asthma, chronic obstructive pulmonary disease, and cancer were considered in early efforts. Searches were subsequently refined for HTN as an exemplar. All articles were reviewed carefully for the development and use of a best practice guide for mHealth apps. The working definition of a best practice guide for this capstone was components of a comprehensive strategy for selecting and using mHealth apps for patients with chronic illnesses wherein the DNP methodically researched, reviewed and assessed the most up-to-date literature on mHealth apps in an effort to align clinical implementation with optimal patient wellness plans consistent with the current state of mHealth technology.

Databases searched included CINAHL, Cochrane Library, PubMed, and ProQuest Health and Medical Complete. Key words were used to narrow the search to find best possible references in the databases. Exclusion and inclusion were used with medical subject headings (MeSH). The literature was limited to less than 10 years old or no older than 2006, full-text, peer reviewed, scholarly journals, English language, and countries of

United States, Canada, Great Britain, and Australia. Keywords and MeSH terms included *mobile devices, mHealth, applications, apps, guidelines, legal, chronic illnesses, hypertension, blood pressure, adherence, self-monitoring, tracking,* and *home monitoring.* The term *hypertension* and the phrase *smartphone applications* were enclosed with parentheses or coupled via Boolean operators with other keywords such as *blood pressure, clinical practice, best practice, chronic illnesses, hypertension adherence, blood pressure hypertension self-monitoring,* or *blood pressure mobile devices*. Initial searches using keywords *blood pressure self-tracking* or *hypertension self-monitoring* yielded greater than 20,000 results on CINAHL, Cochrane, PubMed, and ProQuest.

To narrow the results further, the DNP candidate coupled hypertension blood pressure self-monitoring adherence, guidelines, HIPAA, app, best practice, and protocol with limiters for the literature search including the English language, the time period from 2006 to 2016, publication in scholarly journals, and peer review. With those search criteria, ProQuest yielded 1,485, CINAHL yielded 79, Cochrane yielded 42, and PubMed yielded 74. After gathering relevant information, the DNP candidate refined the search by adding the phrase *mobile devices*. ProQuest yielded 230, CINAHL yielded 518, Cochrane yielded 445, and PubMed yielded no articles. The author reviewed the titles to narrow down articles that would be most appropriate and specific words were excluded such as hospitals, other countries, and adolescents.

Using the Google Scholar database, the phrase *smartphone app blood pressure* was entered, resulting in 17,900 articles. After entering the phrase *smartphone users in US using blood pressure apps for HTN*, Google Scholar produced seven articles but none

of those were applicable. For the final tally, after conducting these data base searches, 62 articles were chosen that all had distinct characteristics deemed necessary for the collection of best practices including reviews by peers, authors with advanced degrees, and associations with reputable research organizations, universities, and governmental departments. After discovering no best practice guides or policies for mHealth apps, Asian countries were added to the search. Some Asian countries had adopted mHealth apps for use in family practice health settings with South Korea being the forerunner. Those articles were read to understand the state of technology in developed countries on the Asian continent.

## The Status of Mobile Health Apps

A point previously made but worth reiteration is smartphones are not equipped with sensors to take reliable measurements of bodily functions other than, possibly, the camera for measuring the heart rate and the accelerometer for measuring movement. Smartphones are, however, equipped with wireless and wired linkages for rapid transfer of data from measurement devices and in the future could act as generic user interfaces for medical devices that simply transmit data bodes well for increased mHealth app usage. The focus for the present was the acceptance of mHealth apps for patient engagement via self-care monitoring activities of the MRTScCI.

A second point for understanding the status of mHealth app technology is the classification of an mHealth app as either stagnant or adaptive. A stagnant app is one that does not consider the past to adjust future activities, whereas an adaptive app adjusts future activities based on past results. For instance, an mHealth app for BP tracking could set reminders to record BP, the frequency being dependent on the value of previous

BP recordings. Higher BP measurements could trigger more frequent reminders to measure BP. In Hochberg et al.'s (2016) study, Type 2 diabetic patients were provided seven text reminders weekly via a smartphone texting service to encourage physical exercise. The text messages were tailored to individuals via the creation of personal profiles for each patient. Text messages also improved over time based on an automated learning algorithm that adapted messages to improve patient adherence. A conclusion of the work was that adaptive technology with mHealth apps was superior to stagnant technology and that adapting functionality of mHealth apps could substantially improve patient outcomes.

Patrick et al. (2008) provided an analysis of future trends of smartphone use and mHealth apps and its inference for use in health care. They foretold the rising prevalence of technology, including mHealth apps, and the way technology would shape the future of healthcare. They urged the health care community to understand and to adopt mHealth technology to improve patient care. Patrick et al. concluded, "Evidence is beginning to emerge about the value of smartphones for the delivery of healthcare services and the promotion of personal health" (p. 6).

Krebs and Duncan (2015) conducted a study to research mHealth app use in the United States. Working through the New York School of Medicine, a cross-sectional survey of 1,604 smartphones in the United States was done. The survey's 36 questions delved into socio demographics, history of mHealth app use to determine the perceived effectiveness of health apps, the reasons for stopping use, and the general health status of the participants. Answers to this questionnaire provided a framework for understanding the current status of mHealth apps. Their data showed most smartphone users had

downloaded at least one mHealth app in general. The following bullets show some of their results:

- 53% had downloaded an app for tracking physical exercise,
- 48% had downloaded an app for tracking food consumption,
- 47% had downloaded an app for tracking weight,
- 34% had downloaded an app for exercise instruction,
- 42% indicated they would not pay for an app,
- 20% indicated they would pay up to $1.99 for an app, and
- 23% indicated they would pay between $2.00 and $5.99 for an app. (Krebs & Duncan, 2015)

Chiauzzi, Rodarte, and DasMahapatra (2015) reported a lack of research on the use of activity tracking monitors and their effects on patients' illnesses. As the population of consumers using activity tracking devices for personal data collection increased, the ability for increased patient engagement in the management of chronic diseases increased. They also reported an increase in patients using wearable devices for activity tracking after surgery. Unfortunately, the information was not integrated into long term healthcare treatment. "Activity has the potential to engage patients as advocates in their personalized care as well as offer health care providers real world assessments of their patients' daily activity patterns" (Chiauzzi et al., 2015, p. 2).

## Hypertension as a Chronic Illness and Exemplar for Mobile Health Apps

Hypertension is a serious problem in the United States and a natural choice of focus since 30% of Americans have HTN and it lends itself to easy self-monitoring (CDC, 2015). The NIH (2015) defined HTN Stage 1 as systolic BP ≥ 140mmHg and diastolic ≥ 80mmHg. Normal BP for adults is defined as a systolic pressure below 120 mmHg and a diastolic pressure below 80 mmHg. Prehypertension is defined as the region between the two. The Eighth Joint National Committee (JNC 8; James et al.,

2014) reviewed research that used evidence-based methods to develop recommendations for HTN guidelines and treatment. The premise of the JNC 8 was the treatment of HTN, a typical chronic disease seen in primary care offices that increases the risk for myocardial infarctions, strokes, renal failure, and death, requires the development of guidelines because patients want assurance the prescribed BP treatment will minimize their disease risk and healthcare providers want evidence-based guidance on the management of the disease.

The CDC (2015) estimated that approximately 30% of Americans have HTN; of them, only 50% of the 70 million adult patients with HTN had adequate control of their BPs. According to the USPSTF (2015), hypertension is the most commonly diagnosed condition in primary care office visits: "In 2010, it was the primary or contributing cause of death for more than 362,000 Americans" (p. 778). Furthermore, USPSTF stated that because HTN is a silent or symptomless condition, many otherwise healthy people are unaware of their condition. Effective treatment options are a balance of preventive behavior, risk-factor management, and medication.

Grossman (2011) reviewed articles in a meta-analysis that demonstrated with a slight decrease in BP of only 10 mmHg systolic or 5 mmHg diastolic, there could be a benefit in reducing heart disease and stroke. Grossman also concluded though that BP lowering should be done within reason--too sharp of a decrease could have deleterious effects. Moser and Setaro (2006) focused on resistant HTN in treating and evaluation. This article began with a case study pointing out common clinical problems. The key point was adherence with constant primary care office visits to follow BPs was critical in cases where BP was resistant to usual interventions.

## The Case for Home Blood Pressure Monitoring and Ambulatory Blood Pressure Monitoring

Pickering, Davidson, Gerin, and Schwartz (2002) defined four groups of people with respect to HTN: true normotensives (normotensive in the clinic, normotensive at home), true hypertensives (hypertensive in the clinic, hypertensive at home), white-coat hypertensives (hypertensive in the clinic, normotensive at home), and masked hypertensives (normotensive in the clinic and hypertensive at home). To define these HTN patients in order to treat appropriately, home BP monitoring is necessary. Thus, the question is not whether home blood pressure monitoring (HBPM) benefits patients HTN but how BP tracking with a mHealth app benefits each of these groups. Only the true normotensive patients have nothing to gain from HBPM. They measure with acceptable BP in the clinic and truly have acceptable BP. White-coat hypertensive patients benefit by not being improperly diagnosed due to their fright in the clinical setting. Masked hypertensive patients represent a danger to the clinician since they could slip through yearly wellness exams. Finally, masked and true hypertensive patients gain from HBPM measurements since those measurements can provide the clinician with a more complete picture of the patient.

The USPSTF (2015) began in 1984 to disseminate evidence-based research (EBR) into the healthcare setting. The USPSTF reported that HTN is the most commonly diagnosed condition in the outpatient setting and is a risk factor for heart disease, strokes, and kidney disease. The USPSTF researched accuracy of measurements used for confirming a diagnosis of HTN after the first primary care office visits and the best rescreening times for diagnosing HTN. "The USPSTF recommends obtaining measurements outside of the clinical setting for diagnostic confirmation before starting

treatment" (USPSTF, 2015, p. 778). The USPSTF also reported that HBPM, ambulatory blood pressure monitoring (ABPM), and in office measurements must be interpreted carefully with each patient.

Hallberg et al. (2015) revealed patients who became involved in their BP tracking study had not previously understood how their lifestyle affected their BP. With accurate recording of BP measurements, they could connect ordinary life events with higher and lower blood pressures, reflect on those connections, and take corrective action to avoid future events that elevated BP. "Almost all the patients had experienced having an 'eye-opener' regarding the importance of good lifestyle with regard to their hypertension. Others said they had made lifestyle changes, such as losing weight or quitting smoking" (Hallberg et al., 2015, pp. 143-144). The study also revealed to the patients the correlation of BP and taking their medication. According to Hallberg et al., once patients saw what affected their BPs, they were more motivated to change their lifestyle.

Stergiou and Bliziotis (2011) conducted a systematic literature search for BP monitoring for diagnosis and treatment of HTN using databases PubMed and Cochrane Library from 1970 to May 2010. They reported the absence of a home-based BP tracking system could lead to inadequate evaluation of intervention treatments for patients who presented with inaccurate high or low BP measurements, i.e. false hypertensives and false normotensives. Although the authors recognized the debate over the usefulness of home BP monitoring, they concluded home BP monitoring was useful for diagnosis and long term treatment of HTN.

Krakoff (2011) demonstrated the benefits of ABPM and HBPM, concluding masked hypertensive patients had a substantial risk of acute cardiovascular events but had

very poorly understood HTN profiles in the absence of HBPMs. According to Krakoff, "With the widespread availability of devices to use at home to measure and record BP, studies have emerged to assess whether HBPM measurement can be implemented to evaluate treatment and improve control" (p. 745). The missing piece was to realize Krakoff's recommendation was an effective method to track home-based BP measurements.

Home-based BP tracking can occur more frequently than clinical tracking, providing the healthcare provider with more complete data for evaluating intervention strategies to lower BP. According to Bengtsson, Kasperowski, Ring, and Kjellgren's (2014) study, patients believed self-tracking of BP was important to improve their BP control. Patients tended to be more compliant to treatment if they understood the relationship between measurements and chronic illnesses and if they engaged in measurements to understand their conditions. "Without self-measurement, it would not be easy to see the relationship between blood pressure values and the patient's general well-being" (Bengtsson et al., 2014, p. 292). Bengtsson et al. found patients wanted to be actively involved in the process to improve their BP.

Krakoff (2011) reported self-management was a strong contributor to achieving success. With control of HTN, overall health improved and overall healthcare costs decreased. Most treatment plans used today for HTN include lifestyle modifications and medications. Issues tend to arise when patients are unaware of their BP levels. Blood pressure measurements inside the clinic do not always show controlled or uncontrolled HTN as BPs can change throughout the day even with medications. "Measurement of

blood pressure outside of the clinic provides a more accurate prediction of future cardiovascular disease than clinic pressure does" (Krakoff, 2011, p. 745).

According to Krakoff (2011), use of mHealth apps is becoming increasingly valuable in self-care of chronic diseases such as HTN. Differences between using a mHealth app and paper for tracking BP measurements have been researched. Walther et al. (2011) studied PDC versus EDC. The primary advantage found for EDC was data were archived for easy access and availability. Another advantage according to Walther et al. was time savings. For a person who understands how to use electronic data, access for review and analysis is much more rapid than paper. Walther et al. also found data entry errors were the same for both EDC and PDC. The obvious benefit for using a mHealth app is people who carry their smartphones with them can always collect data and present them to their healthcare providers.

Both Frost and Hajjar (2005) and Shimbo, Abdalla, Falzon, Townsend, and Muntner (2015) sought to understand differences among clinical BP measurements, ABPM, and HBPM with respect to HTN. The primary conclusion was ABPM and HBPM were far superior for the creation of a comprehensive wellness plan than clinical BP monitoring but the subtleties between ABPM and HBPM were not yet completely understood.

As noted previously, many studies reported that multiple measurements over a longer time period are more successful in foretelling risk and controlling HTN than a single measurement done in the clinical setting once or twice a year. Since BP is affected by short term incidents such as physical exertion, emotion, stress, pain, food, beverages, and/or current drugs, the single office measurement is not an indicator for ruling HTN in

or out and frequently not sufficient in and of itself to modify treatment. Data collected from USPSTF (2015) reported a significant number of patients measured in a clinical setting and diagnosed with HTN were believed to have BP lower than the defined range of HTN or those diagnosed with low BP had higher than what was documented. These false hypertensive and false normotensive patients could be provided with inappropriate treatment plans. In particular, false normotensive patients would be subject to increased risk if taking a medication they truly did not need. False hypertensive patients would not be getting the proper treatment they needed and would be exposed to a greater incidence of acute, life-threatening health events.

Issues that arise with measurement errors in the office setting include more than just the "white coat" phenomenon. Measurements in the office are inherently much more infrequent than measurements taken in home settings and the limited number of measurements could lead to an improper diagnosis. Furthermore, office staff are often poorly trained and can unknowingly record incorrect data. Krakoff (2011) and USPSTF (2015) reported BP self-tracking at home could substantially augment patient data, have a direct effect on creation of wellness plans, and thus decrease the likelihood of cardiovascular events, stroke, and all-cause mortality.

## The Case for Blood Pressure Tracking Apps for Patients with Hypertension

According to Stergiou and Bliziotis (2011), the evidence was irrefutable for the diagnosis, continued treatment, and care of HTN with home self-tracking BP tracking. Stergiou and Bliziotis's study found "current technology of BP monitoring software can easily fulfill these requirements with minimal increase in the cost. This is an essential

prerequisite for physicians to rely on home BP measurements in making treatment decisions in clinical practice" (p. 131).

Literature on mHealth app use for HTN was wide and diverse, encompassing many different aspects of HTN management. Some articles attempted to create reviews to concentrate the disjointed information from many articles into easily accessible bundles. Although still somewhat difficult to glean from the literature, several common themes about mHealth apps prevailed. These themes included the positive aspects of BP tracking mHealth apps, notably their capability, effectiveness, and patient satisfaction, and the negative aspects, notably their usability, barriers, and limitations. The gleaned themes also included logistical issues, notably security issues, legal issues, safety, cost, and their effects on adherence and compliance to treatment plans.

## The Positives: Capability, Effectiveness, Patient Satisfaction

Kang and Park (2016) noted the absence of a best practice guide for mHealth app usage for patients with HTN and set to write a truly evidence-based HTN blood pressure tracking app that would rank highly for usability and user satisfaction. The HTN management app development was guided by the Web-Roadmap methodology and included planning, analysis, design, implementation, and evaluation phases. Key questions concerned the effectiveness of mHealth apps for hypertensive patients in terms of usefulness, satisfaction, and medication adherence. The final product, a mHealth BP tracking app that stored and then transmitted data to healthcare providers, was given to patients diagnosed with HTN. Patient satisfaction with the process was high except for the effort required to transmit data to providers. Kang and Park interpreted that observation as a failure of providers to fully embrace the electronic era, requiring clinical

visits after BP data transmission to the provider. Patients felt transmitting data and then visiting the clinic was a doubling of effort without a clear benefit. However, the main conclusion of the study was "the development and correct utilization of such an app could help patients with hypertension improve their lifestyle and increase their medication adherence through drug education and medication reminders" (Kang & Park, 2016, p. 1).

Cho, Park, and Lee (2014), in a study regarding motivation for use of an mHealth app, reported the younger population was more proficient in health app use. Those with a higher education level were also more proficient with mHealth app use. The report also suggested men were more health conscious and had higher literacy with health apps. They noted a correlation that those who were more health conscious were also more likely to use health apps and be more proficient with those health apps; ongoing use tended to decrease as health apps became more intricate. The more an app was used by an end user the greater the likelihood of ongoing use. The study concluded the need for practitioners to keep chosen apps simple with very few buttons to push.

## The Negatives: Usability, Barriers, and Limitations

Chiauzzi et al. (2015) reported on activity monitoring mobile devices sold in 2015 in an effort to determine if activity monitoring devices could improve health outcomes for chronically ill patients. Their hypothesis was improved health outcomes required long-term usage. They found many studies reported on the feasibility of such devices to improve health outcomes but the literature was nearly void of studies attempting to determine factors that promoted long-term use of devices. The authors stated one path to long-term usage was the creation of a patient-driven healthcare system that included greater patient-provider interaction, expanded social networks for buddy support, and

increased use of data by patients themselves. From a patient perspective, long-term usage required improvements including extended battery life, easier syncing, additional sensors, improvements in aesthetics, and resolution of technical difficulties.

Fletcher and Jensen (2015) wrote an article reviewing publications in which barriers were discussed regarding seniors 65 years and older. It was a meta-analysis using databases CINAHL, PubMed, IEEE, and Google Scholar. Medical subject headings and keywords used were *mobile health*, *mobile technology*, *wireless communications, aged, elderly, cellular phone*, and *usability*. Research from the meta-analysis concluded elderly patients had many barriers that prevented them from using the new smartphone technology. The barriers discussed included decline in physical barriers, negative attitudes, and cognitive, sensory, and motor deficits. The report concluded that as technology advances in smartphone technology, healthcare providers must seek ways to help the 65 years and older population work with the new technology.

Mirkovic, Kaufman, and Ruland (2014) wrote a paper in an effort to understand the usability of mHealth apps for use with cancer patients and treatment. The app helped with symptom management and patient-provider communication for treatment in the cancer disease. Interviews were conducted for patient feedback on the app to understand its usefulness, identify the need for additional features and design, and measure the approval of the mHealth app management in everyday life. The majority of complaints were due to difficulty with input and a crowded screen display (Mirkovic et al., 2014).

Fletcher and Jensen (2015) researched barriers for the elderly and the use of smartphones to assist healthcare providers with ways of overcoming those barriers. They cataloged barriers as physical barriers, acceptance barriers, and barriers due to design.

Physical barriers included intellectual barriers such as weakened cognitive skills in older patients and poor dexterity for arthritic patients. Acceptance barriers involved attitudes and preconceived opinions patients had about smartphone technology. Barriers due to design were those barriers created by poorly conceived apps. Other research echoed these barriers including one group that concluded "data validity, usability, programmatic integration, clinical integration, and user data privacy must be addressed" (Chiauzzi et al., 2015, p. 5).

Scherr et al. (2009) reported on the impact of home-based tele monitoring using smartphone technology for patients with heart failure. The article addressed limitations with some patients, especially the elderly where cognitive skills were reduced as well as dexterity, vision, and fine motor skills. They found patients using the smartphone devices had reduced hospitalizations and concluded that a key element to adherence to smartphone monitoring was simplicity and usability of the device. Scherr et al. noted even adequate instruction on the smartphone application was a challenging part of the study for elderly patients with very limited skills for high tech devices such as smartphones. Their research showed new mHealth app technology for elderly patients or those patients with limited cognitive function might be an issue in clinics where staffing and time are inadequate for patient instruction.

Some literature reviewed for this capstone addressed methods to create accessible, user-friendly mHealth apps. Schmidt (2012) wrote an article for mHealth app developers to help with design and ease of use. The author emphasized the need to keep the design simple and not busy, to make navigation in as few steps as possible, and to make buttons on the layout easy to spot and sufficiently separated for patients with limited manual

dexterity. Billi et al. (2010) reported on a structured approach to evaluate the accessibility and usability of mHealth apps. The basic concept of the work was to use an automated methodology to create user apps that would display well on a range of mobile devices and be aesthetically pleasing to a diverse audience. The salient point of this work was mHealth apps should be professionally written with specifically designed methodologies to optimize user experience.

## The Logistics

The logistics of mHealth apps is a broad theme covering many different topics. Included in this theme are the professionality of the mHealth app, security issues, legal issues, safety, and cost. According to Boudreaux et al. (2014), seven strategies must be followed before making a recommendation for an mHealth app for healthcare: conduct a review of the scientific literature, search app clearinghouse websites, search app stores, review app descriptions and user ratings, conduct a social media query within professional and/or patient networks, pilot the apps, and request feedback from patients (Boudreaux et al., 2014). The end user, either the patient or the provider, might not know if a particular mHealth app was written by professional or amateur and if the developers considered the seven recommended strategies.

Concern about the security of data was one reason given for those who had not downloaded an mHealth app; those people who had downloaded an mHealth app had relatively little concern for security. According to one study, people who were using mHealth apps reported "trust in their accuracy and data safety was quite high, and most felt that the apps had improved their health" (Krebs & Duncan, 2015, p. e101). In this study, the majority of concern regarding mHealth apps was cost. Most of the participants

in the survey were adamant about not paying anything for a health app. Whether free or at a cost, half of the mHealth app respondents using a mHealth app had discontinued using it after a trial period (Krebs & Duncan, 2015). The reasons for discontinued use of the mHealth app included cost, complexity, privacy of personal data, and lack of interest. The conclusion of the Krebs and Duncan study was for a mHealth app to be successful, designers need to address the aforementioned concerns.

E. Liprandi, a senior software engineer at Snapfish LLC and developer of mHealth apps, was consulted for this capstone (E. Liprandi, personal communication, February 24, 2016). Although mHealth apps enable many tasks that are otherwise difficult to maintain in practice, they also present important risks. Most importantly, mHealth app software is easy to write and not well regulated including medical accuracy, e.g., details about what data are transmitted and how stored data are not easily ascertained without involvement from the developer. Such risks are possible violations of HIPAA (1996) laws. As a case in point, Vijayan (2012)--an author who works for the magazine *Computerworld*, a magazine and website that disseminates news and articles for information technology--reported on lawsuits against companies stealing data from mHealth apps for inappropriate uses.

LoPresti et al. (2015) conducted a study to review up-to-date articles and trials involving mHealth apps for worldwide use. They reported mHealth apps were expanding exponentially as their usefulness for monitoring, tracking, and reporting in healthcare settings improved. Their study concluded with outlining the need for more research on how best to use the mHealth apps since evidence was still low. “While this technology is

most assuredly the way of the future, it is important that consideration is given to ensuring their appropriate and safe use in health care" (LoPresti et al., 2015, p. 24).

Lewis and Wyatt (2014) researched limitations and barriers associated with mHealth apps and concluded most mHealth app developers had little to no formal medical education. This lack of education could result in mHealth apps not having appropriate safeguards for HIPAA (1996) regulations. Another issue noted was the large volume of apps available for health issues--a number too great for regulation by the Federal Drug Administration (FDA). A poorly written app with an attractive user interface represents risk to the reputation of clinical providers who recommend them based on apparent value without clear information of safety. Also, patient care and reputations of clinical staff could be threatened by inappropriately recommended apps. Lewis and Wyatt (2014) concluded that education of both clinicians and patients, not avoidance, was needed to meet the apparent future.

## Adherence and Compliance with Mobile Health Apps

Cocosila and Archer (2005) attempted to understand factors that contributed to adherence issues with wellness plans, concluding the mHealth apps could serve six functions to help improve patient adherence: monitoring, reminding, consulting, supporting, informing, and educating. The benefits of mHealth apps include diminishing forgetfulness, improving motivation, increasing optimism, reducing stress, improving self-confidence, providing encouragement, improving patient knowledge, and promoting adherence (Cocosila & Archer, 2005, table 1).

Bengtsson, Kasperowski, et al. (2014) conducted a study with a team of interdisciplinary group of providers working with patients diagnosed with HTN and

healthcare professionals. The purpose of the study was to understand and explore HTN treatments in order to develop interactive smartphone apps to promote patient adherence to wellness plans. Two articles were written from this study's efforts. In the first article, Bengtsson, Kasperowski, et al. developed an appreciation for the needs and desires of patients to understand how BP manifested itself in ordinary daily events and lifestyle. In the second article, Bengtsson, Kjellgren, Hoeffer, Taft, and Ring (2014) used their understanding to develop mHealth apps for BP monitoring, concluding improved home BP monitoring helped patients control their HTN and lead better lives.

Hallberg et al. (2015) interviewed patients using mHealth apps in an effort to gather patients' experiences with mobile tracking devices and technology. The process was guided and outlined by the U.S. Food and Drug Administration's patient-reported outcome measures guide. The research study focused on two key questions for data collection. The first question concerned patients' experiences with smartphone BP apps. The second question concerned the ability of smartphone BP apps to help manage blood pressure. The authors concluded patients were energized by the ability of mHealth apps to make connections between BP measurements and ordinary experiences in their daily lives.

## A Best Practice Guide for Mobile Health Apps

Even though the amount of literature on the use of mHealth apps in the healthcare arena was vast, comprehensive efforts by the DNP candidate to find studies on the development of a best practice guide for mHealth apps associated with HTN were unsuccessful. Mobile health apps, as with most components of the information age, have great potential to be poorly understood and even misused. For instance, some mHealth

apps advertise an ability to measure BP in addition to tracking it. However, smartphones do not have a suitable device for measuring BP. Many patients also do not fully grasp HIPAA (1996) laws and the need to protect their healthcare privacy. Learning how to handle collected data is important.

Implementation of mHealth technology is as incomplete as it is exciting. Patrick et al. (2008) addressed issues related to smartphone technology and concluded policies are still needed. Since mHealth app policies might have an impact on how healthcare practices use smartphone technology, the policies should be given consideration from not only clinics but the entire healthcare community (Patrick et al., 2008).

In their concluding statements, Chiauzzi et al. (2015) wrote that as the prevalence of chronic illnesses increases, the demand for mHealth apps will increase and their impact on chronic disease management will be great. The ability for mHealth apps to change patients' behaviors in self-management of their illness is astounding. To achieve this potential for success, a best practice guide for effective clinical integration of mHealth apps for chronically ill patients needs to be developed (Chiauzzi et al., 2015).

Mobile health technology provides new opportunities that can support self-management behavior for patients with chronic illnesses. Patrick et al. (2008) summarized the status succinctly. If health care providers want the technology of smartphones to be used to the fullest potential to support health care improvements, healthcare staffs of clinics must initiate discussions and develop a best practice guide to standardize use.

A key message gleaned from the literature review was the use of mHealth apps should increase in an on-going effort to battle chronic illnesses. An aging population and

obesity are clearly contributing to a rising prevalence of chronic illnesses, especially HTN in America. Technology and, in particular, mHealth apps have proven to be effective in the battle to reverse that trend. Yang and Silverman (2014) took this argument one step further with a very bold statement:

> However, as health apps become more prevalent, a standard of care for their use may emerge. For example, failure to use an app could be considered a breach of the standard of care if a reasonably prudent practitioner would have used the app under similar circumstances. (p. 225)

Mobile health apps use may very well become the standard of excellence and not the exception in future clinical settings.

## Project Purpose, Objectives, and Design

### Purpose

The purpose of this project was to develop a best practice guide for mHealth apps to help guide healthcare providers in treatment of patients with chronic illnesses. Mobile health technology is available with new opportunities that can support patients with chronic illnesses, although best practice principles and guides are not well established. Patrick et al. (2008) summarized that health care providers must discuss and standardize treatment strategies if they want the technology of mHealth apps to be used to the fullest potential to support healthcare improvements. "As activity devices become part of the treatment prescription, behavior change programs are used to engage patients in self-management, and best practice for clinical integration are defined" (Chiauzzi et al., 2015, p. 1).

As technology improves on smartphones, the opportunity to engage patients in self-management increases. Patients who are actively involved in their health care have better outcomes, have reduced clinical primary care office visits, and have lower overall

cost of their health care (Hallberg et al., 2015). Mobile health apps provide a unique opportunity for patients with a chronic illness such as HTN since the app can illuminate the nearly asymptomatic character of the condition.

Mobile health apps used to improve health, including those designed to track BP, are proliferating. Apps may be easily downloaded to smartphones via the Apple App Store for iPhones and the Google Play Store for Android phones. The selection of mHealth apps for this capstone was guided by Apple App Store user ratings, Google Play Store user ratings, Roth and Cherney's (2015) review of heart disease apps, Lewis and Wyatt's (2014) research, Fletcher and Jensen's (2015) research, and the HealthIT.gov (2013) website. Considerations used for selecting mHealth apps for this project were cost, ease of use, display, privacy issues, and steps in navigation. The mHealth app selected for this project was Blood Pressure--Smart Blood Pressure (SmartBP) BP Tracker.

The target populations for this project were patients with chronic illness but with a focus on just one chronic illness--HTN. Those patients included adults over 18 years of age diagnosed with HTN. With the rise in mHealth apps, the possibility of at-home BP tracking to aid healthcare providers in treatment optimization for patients is real. Populations most likely to use mHealth apps are usually at least 18 years and older, have higher incomes, have more education, are Hispanic ethnicity, speak English, have a body mass index (BMI) in the obese range, and own a smartphone (Krebs & Duncan, 2015).

The function of this capstone was to begin with the evidence-based conclusion that HBPM and ABPM tracking can assist with optimization of health care for patients

with HTN and end with a best practice guide and a practical method of disseminating HBPM through app use into the relationship between the provider and the HTN patient.

This capstone was consistent with the National Health Services Institute for Innovation and Improvement's (2008) goal to produce *Protocol Based Care* for improving safety, consistency, and quality of care. This task--safety, consistency, and quality of care--resides within the realm of DNP nurses (Waldrop et al., 2014). According to Waldrop et al. (2014), five objectives must be met for a final DNP capstone: enhancing health outcomes, culminating a practice inquiry, engaging in partnerships, implementing/applying/translating evidence into practice, and evaluating the outcomes of the change. The objectives for this capstone were as follows:

**Objectives**

**Objective 1: Enhancing health outcomes.** This project was to create a best practice guide for the future use of patients with chronic illness using mHealth apps to aid in the treatment of chronic illnesses in healthcare settings. Self-tracking of a chronic illness such as BP with the use of a mHealth app is an excellent choice to assist in engaging patients and guiding long-term treatment of a chronic illness such as HTN.

**Objective 2: Culminating a practice inquiry.** The search for current literature combining mHealth apps with chronic illnesses in a clinical practice yielded many articles that contained a broad array of themes. Clearly missing among these themes was the distillation of knowledge for a best practice guide. This practice inquiry showed the future use of mHealth apps will be extensive since they can add a missing dimension to the treatment of chronic illnesses. A best practice guide for the use of mHealth apps for

patients with chronic illnesses could accelerate the adoption of mHealth app technology and ensure medical professionals stay ahead of the general public with mHealth app use.

**Objective 3: Engaging in partnerships**. During this capstone, many collaborations were formed among the DNP candidate and healthcare professionals including two medical doctors, two physician assistants (PA), and two family nurse practitioners (FNP). The DNP candidate did not access patients or patient records for the purpose of this capstone. A distinct partnership made during the capstone was between the DNP candidate and a senior software engineer at Snapfish, LLC (E. Liprandi, personal communication, February 24, 2016). An extensive discussion provided insight into the nature of mHealth app creation. A key point was mHealth apps might either overtly transmit data to a server, giving the user a message or log to herald the event, or might covertly transmit data to the designers for the purpose of marketing. Future work on mHealth apps to aid in patient care should incorporate direct interaction with mHealth app designers to fully understand the nature of transmitted data.

**Objective 4: Translating evidence into practice**. Evidence in the literature pointed to the irrefutable conclusion that use of mHealth apps for patients with chronic illnesses such as HTN engaged patients improved BP data for decision making, contributed to self-care monitoring of the MRTScCI, and improved outcomes. Use of mHealth apps was not yet the norm. A best practice guide disclosed in this capstone was presented to a group of volunteer healthcare providers in an effort to translate evidence into practice. The hope was this capstone would be a catalyst for the adoption of mHealth apps to help aid in a patient treatment plan for clinics motivated to adopt innovations.

**Objective 5: Evaluating the outcome of change**. The change proposed in this capstone was the development of best practice recommendations for providers when implementing mHealth apps for patients with chronic illnesses. In an effort to define the success of this capstone, the DNP candidate asked a group of volunteer healthcare providers to complete an evaluation questionnaire. The questionnaire was designed to gauge the ability of the best practice guide to encourage providers to adopt mHealth apps in routine care of patients with chronic illnesses.

**Design**

The evaluation questionnaire (see Appendix A) was created using the Qualtrics© application on the University of Northern Colorado website. Qualtrics is a user-friendly, web-based application designed for the administration of questionnaires and surveys. Particular questions on the survey were designed from articles written to guide in design of a questionnaire. The website for the questionnaire was given to providers following the presentation of the capstone. All answers were anonymous. Answers to the questions helped the DNP candidate determine if the capstone motivated them to consider disseminating mHealth apps to motivated patients or if barriers to the innovation still stopped deployment.

## Summary

The purpose of this project was to develop a best practice guide for use of an mHealth apps to help guide healthcare providers in treatment of chronic illnesses. Mobile health technology will increase and bring with it unique issues that should be addressed with a best practice guide. The new best practice guide was designed to have

an impact on how healthcare clinics adopt and implement mHealth technology and should be given consideration from not only clinics but the entire healthcare community.

# CHAPTER III

# EVALUATION PLAN

## Evidence-Based Quality Improvement

During the literature review, no guidelines, protocols, or best practice guides were discovered for any mHealth apps including mHealth apps for patients with chronic illness in the nursing literature. There were no documents regarding the use of smartphone technology in family practice settings on CINAHL, ProQuest, or PubMed.

Numerous mHealth apps exist including those for tracking BP. Many applications are free and have similar capabilities and similar rankings. This evidence-based best practice guide focused on mHealth apps that serve patients with chronic illnesses, using the exemplar of HTN to track BP measurements. Best practices for mHealth apps addressed were as follows:

- What to include and not include in mHealth apps
- Selection of mHealth apps
- When to use mHealth apps
- How to introduce mHealth apps to patients /populations
- Instruction for mHealth apps that address health literacy in addition to general literacy
- How to document information obtained from mHealth apps
- Limitations and barriers

- HIPAA/legal Issues
- Where to obtain accurate measurements when needed for mHealth apps (BP is the exemplar)
- Times to measure attributes needed for mHealth apps (BP is the exemplar)

## Timeline of the Plan

The basic concept of this capstone took shape in the summer of 2015 and morphed several times during the fall of the academic year. The idea for the capstone was the desire to combine new smartphone technology with the healthcare industry's need to collect better patient data efficiently and engage patients. Early incarnations of this capstone involved exploring the possibility of conducting clinical trials at local healthcare clinics. During these early stages, the lack of best practices became apparent to the DNP candidate. Thus, the lack of a best practices guide inspired this capstone.

This best practice guide was presented on multiple dates as an oral presentation to different groups of volunteer healthcare providers in northern Colorado including primary care providers delivering care to varied socioeconomic groups. The group of volunteer healthcare providers provided feedback through the provided Qualtrics survey link.

## Benefits and Risks of the Project

Risk associated with this capstone was minimal since the goal of the capstone was to create a best practice guide for mHealth app use with existing treatment plans. The best practice guide presented here does not supplant the usual wellness plans created during office visits. Risks associated with use of the mHealth apps recommended in this capstone were also minimal. First, the financial risk was minimal since costs associated with BP tracking and mHealth apps were relatively low as the mHealth apps chosen in

this exemplar were free. Patients without a smartphone simply did not participate in any pilot program to employ mHealth apps technology. Second, no patient records were needed for defining a best practice guide so research of patient records was not needed. Third, issues associated with breaches of HIPAA (1996) laws and possible malpractice lawsuits in cases where mHealth apps provided false information that led to patient injury, as discussed extensively by Yang and Silverman (2014) and by Bengtsson, Kjellgren, et al. (2014) were factored into this capstone. The best practice guide promotes self-care management using medical apps on smartphones to provide a more comprehensive picture of a patient's health care status, engage the patient in self-care activities, and energize the patient in the battle against his/her chronic illness. The possibility of HIPAA violations was mitigated by choosing mHealth apps that did not transmit data.

The primary benefit of this capstone was it acted as a primer for clinics to create pilot programs to improve wellness plans for patients with chronic illnesses. Many mHealth care apps exist and the pros and cons of each were not easily gleaned in a few-minute trial. Rather than search literature to understand risks and benefits of a particular mHealth apps, interested providers could choose a mHealth app from the information provided here. By providing a primer, the DNP candidate could help clinics jumpstart programs to explore the viability of mHealth apps for the augmentation of wellness plans for patients with chronic illnesses.

## Resources for Project

This capstone was modest in its need for personnel and financial resources. The main resources incorporated into the project were manpower and time provided primarily

by the DNP candidate. Resources included Internet access for the literature review and data mining, iPhone and Android smartphones with smartphone data service for evaluation of mHealth apps, and the group of volunteer healthcare providers for constructive feedback on the quality of the best practice guide. The DNP candidate used information from National Health Services Institute for Innovation and Improvement (NHS; 2008) as a guide for developing this project.

Resources used for the evaluation questionnaire were created with the Qualtrics application on the University of Northern Colorado website. Qualtrics is a user-friendly, web-based application designed for the creation of questionnaires and surveys. The DNP candidate developed the Qualtrics questionnaire. The questionnaire link was given to providers following the mHealth primer presentation.

This project did not require a financial budget for costly resources such as equipment and professional personnel to conduct meetings. Technology used for this capstone was inherently quite high-tech and costly but large market acceptance took advantage of economies of scale to reduce costs. Many effective mHealth apps are free since their costs of creation are relatively low. Software developers often receive grant money from research institutions to write mHealth apps and on-going costs are often paid by advertisements or simply by hosting healthcare institutions as part of their business models.

## Stakeholders

Healthcare providers and patients were the main stakeholders of the capstone. Other stakeholders included medical assistants and administrative staff at the healthcare facility. Secondary stakeholders, those getting the benefit of the healthcare improvement,

were the communities and families. Many stakeholders benefit when the residents of a community have improved healthcare such as decreased healthcare costs.

## Applications and Agreements

A memorandum of understanding between the DNP candidate and the volunteer providers was not needed since the volunteer providers simply listened to an oral presentation and critiqued the best practice guide. An application for Institutional Review Board with the volunteer providers was not required since human subjects were not involved and private information was not disclosed. The Institutional Review Board of the University of Northern Colorado granted exempt status approval (see Appendices B and C).

## Evaluation Plan

The purpose of this capstone was to develop a best practice guide for mHealth apps for patients with chronic illnesses with HTN as an exemplar. The best practice guide was designed to assist healthcare providers in the implementation of mHealth apps as a component of treatment plans for patients with chronic illnesses. The purpose of a questionnaire was to obtain qualitative feedback from healthcare providers following a face-to-face presentation of the capstone. An evaluation questionnaire was created with a Qualtrics application, a web-based application designed for the administration of questionnaires and surveys, on the University of Northern Colorado website. This questionnaire (see Appendix A) was developed by researching best questionnaire design ProQuest to make it specific for chronic illnesses and to address the capstone goals for mHealth implementation. The DNP candidate developed the Qualtrics questionnaire and handled all logistics of administration with the help of the capstone committee. The

questionnaire link was given to providers following presentation of capstone. The DNP candidate collected and collated the responses to the Qualtrics questionnaire from the Qualtrics website. A synopsis was created for discussion with the capstone committee. Aggregate results are reported in this capstone document.

## Survey

Summation evaluation was a valuable part of the design. Since this capstone for the creation of a best practice guide for mHealth apps using HTN as an exemplar is novel, no works for comparison existed in the available literature. The closest match was a best practice guide found during the literature search developed for mHealth cancer apps and mHealth diabetes apps. Use of Melynk and Fineout-Overholt's (2011) *Evidence-Based Practice in Nursing and Healthcare: A Guide to Best Practice* also guided in the writing of this best practice guide for mHealth apps.

The summation evaluation considered the entire project and asks the following valuable questions:

1. Should the project continue?
2. If yes, are there changes to be made?
3. How sustainable is the project?
4. What components helped or limited this project?
5. What recommendations could be made?

## Summary

Smartphone technology is mature and apps are inexpensive, yet the implementation of mHealth apps technology in the mHealth arena for management of chronic illnesses is still in its infancy. Smartphones do not yet have sophisticated input

devices to enable measurements such as BP, glucose levels, or levels of various proteins in the blood. However, they could be linked to such devices via cabling or Bluetooth connections for future applications. In such cases, mHealth apps would act as a graphic user interface to enable the patient to access the functionality of the device.

At present, the primary benefit of combining use of mHealth apps and patients with chronic illnesses is the ability to improve patient engagement through improved self-monitoring and to track HBPMs. Such measurements have the possibility of engaging patients in self-care activities and providing healthcare care givers with a much more complete picture of a HTN patient's state of health. A complete picture enables an entirely new dimension in health care management that could help providers reverse the increasing trend symptoms associated with chronic illnesses.

The primary risk of mHealth apps is the deliberate or inadvertent violation of HIPAA (1996) laws. This risk is inherent in its basic ability to store and to transmit data easily. Mobile health apps need oversight and regulation by appropriate authorities before full adoption by the healthcare community. This capstone balanced the exciting possibilities of mHealth apps for chronic illnesses management with a conservative approach to avoid complications with HIPAA violations. The chosen mHealth apps for this capstone best practice guide stored and recorded data locally for manual review between patient and provider and the creation of optimal wellness plans.

# CHAPTER IV

# RESULTS

## Review of Purpose and Objectives

### Purpose

The purpose of this capstone was to develop a best practice guide for the usage of mHealth apps to aid in the care of chronically ill patients (see Appendix D). The best practice guide was designed for provider usage rather than patient usage; it includes an introduction, a description of when to use mHealth apps, a description of how to use mHealth apps, and a description of what to include and not include when researching mHealth apps. Five objectives of this capstone were met.

### Objective 1: Enhancing Health Outcomes

A best practice guide for the future use of patients with chronic illness using mHealth apps to aid in the treatment of chronic illnesses in healthcare settings was written, presented, and evaluated. Numerous evidence-based research articles were presented that showed that mHealth apps improve patient care by (a) empowering patients to understand their chronic illnesses better, (b) providing better clinical data to providers, and (c) enabling patients to self-manage their chronic illnesses.

### Objective 2: Culminating a Practice Inquiry

The practice inquiry of this capstone concerned the status of mHealth apps in the treatment plans of chronically ill patients. The search for current literature combining mHealth apps with chronic illnesses in a clinical practice yielded many articles that demonstrated the benefits of mHealth apps. The plethora of evidence showing the benefits of mHealth apps stood in stark contrast to the lack of available best practice guides to promote the adoption of mHealth apps for providers. Clinical providers are busy professionals who do not in general have time to search the literature to determine the benefits and risks of mHealth adoption, develop a systematic approach for selecting mHealth apps, and promote usage among patients. The primary conclusion from the practice inquiry was the need for a best practice guide to accelerate adoption of mHealth apps in clinical settings.

### Objective 3: Engaging in Partnerships

During this capstone, many collaborations were formed between the DNP candidate and healthcare professionals including two medical doctors, two physician assistants (PA), and two family nurse practitioners (FNP). These partnerships became a valuable source of inspiration for the DNP candidate, demonstrating to the DNP candidate that clinical providers are amenable to the adoption of mHealth technology and obtain value from a best practice guide to accelerate learning. Discussions with these partners encouraged the DNP candidate to complete the best practice guide.

### Objective 4: Translating Evidence into Practice

The evidence in the literature proved mHealth apps in general improved patient treatment plans. This evidence alone should translate into widespread clinical adoption of mHealth apps. However, mHealth apps do not appear to be widespread in clinical implementation. The root cause of the mismatch between the benefits and mHealth app usage and the adoption of mHealth app usage was assigned to a lack of easily accessible clinical information such as a best practice guide. The created best practice guide was general in construction, providing instructions on the value of mHealth apps and methods to select and evaluate mHealth apps for patients with chronic illnesses.

### Objective 5: Evaluating the Outcome of Change

The change proposed in this capstone was development of best practice recommendations for providers for the implementation of mHealth apps for patients with chronic illnesses. A questionnaire was designed to gauge the ability of the best practice guide to encourage and to energize providers to consider promoting mHealth app usage for patients with chronic illnesses. The results of the questionnaire were gathered, summarized, and are presented later in this capstone document.

## Key Facilitators and Barriers that Impacted Project's Objectives

The key facilitators that impacted the project's objectives were the maturity and the cost of mHealth apps. Mobile health apps exist for a wide range of chronic conditions and are often free of charge or available for a nominal fee. Mobile health apps can easily be added to patient treatment plans without substantial and costly overhead. For instance, had a key component to mHealth app augmentation of treatment plans been

the development of a remote server for data storage, mHealth app adoption would represent a major change to clinics. Had mHealth apps typically been expensive, providers would not have been amenable to implementation. The simplicity and capability of local data storage on patients' smartphone represented the dominant facilitators to promote expanded adoption of mHealth apps for patients with a wide range of chronic illnesses.

The key barrier that impacted the project's objectives was the inability to implement mHealth apps in selected clinical trials to develop first-hand experience with mHealth app usage. The best practice guide is meant to be a resource for providers to accelerate adoption of mHealth apps. First-hand experience with mHealth app implementation would have provided the DNP candidate with a greater appreciation for the necessary content of the best practice guide. For instance, the DNP candidate used HTN as the exemplar with SmartBP as the selected mHealth app. However, the DNP candidate did not have the opportunity to implement SmartBP, gain feedback from patients, and use that feedback to improve the best practice guide.

## Best Practice Design Summation

For the selection of mHealth apps and the creation of a best practice guide, the National Institute of Health (2016) has published a guide for designing and writing printed easy-to-read materials. The National Health Services Institute for Innovation and Improvement (NHS; 2008) also provided resources to assist with both the selection of mHealth apps and the creation of an effective best practice guide. Mobile health apps should be clear and simple and should be written with the assumption that the end user might not have an advanced education. A best practice guide for providers must be a

concise and effective document to accelerate implementation of mHealth apps into treatment plans. A best practice guide should not be cumbersome or wordy but, being written for providers, does not need to be overly simplistic.

Some of the recommendations were specific for mHealth app selection, some directed the creation of the best practice guide, and some were applicable to both. The recommendation relevant for mHealth selection was to keep within a range of about a sixth to seventh grade reading level. This reading level was especially important in the first few lines of text. A reader who has difficulty at the beginning might stop reading. Other recommendations applicable to the content in an mHealth app included:

- Use words like "you" instead of "the patient."
- Some users prefer step-by-step instructions. Others may find concepts arranged from the general to the specific easier to understand. The order may also depend on the type of task being describing. Some tasks must be done in a step-wise way and others do not.
- People for whom English is a foreign language may have not learned medical or health terms. Find alternatives for complex words, medical jargon, abbreviations, and acronyms to improve understanding.

For recommendations applicable to the creation of a best practice guide for providers, the NHS (2008) suggested implementing standards and determining best care practices through literature review, which was met for this capstone. Other concepts helpful for the creation of the best practice guide included:

- Focus on two to three key concepts.
- Use a clear topic sentence at the beginning of each paragraph. Follow the topic sentence with details and examples. For example, "The following items should be asked when selecting a mHealth app" and then list the questions in bullet form for clarity.
- Use illustrations and photos with concise captions. Keep captions close to photos and illustrations.
- Make print large enough for the target audience. Usually Times New Roman 12 point is adequate.
- Use bold headings and subheadings to separate and highlight document sections.
- Only justify the left margin. This means the left margin should be straight and the right margin should be "ragged."
- Use column widths of about 30-50 characters long (including spaces) or three to five inches.
- Do not print text on top of shaded backgrounds, photos, or patterns. Keep most sentences 10-15 words long. Use varied sentence lengths to make them interesting but keep sentences simple.

Most recommendations by NHS (2008) were applicable in general to both mHealth app selection and best practice guide creation:

- Structure the material logically but include the most important points at the beginning. The mHealth app must grab the reader's attention at the

beginning. People often do not read all the text and may miss key points as the best information is saved for the end.

- Include specific actions the reader may or should take. The document's purpose should not be solely to inform but also to get the reader to take action.
- Avoid abstract words and instructions for actions. For example, instead of writing "Providers may view patient data by any means," write "Providers may view patient data in several recommended ways" and then list the ways in bulleted form.
- Emphasize the benefits of the desired behavior. For example, " A primary goal of mHealth app usage is better patient engagement and adherence."
- Do not make assumptions about people who read at a low level. Do not talk down to the reader. Maintain an adult perspective.
- Where appropriate, use bulleted lists instead of blocks of text to make information more readable.
- Use the active voice and vivid verbs.
- Be consistent with terms. For example, do not use "mHealth apps" and "smartphone apps" interchangeably in the same document.
- When possible, say things positively, not negatively.
- Use colors that are appealing to the target audience. Be aware, however, that some people may be color blind and may have trouble distinguishing red from green.

- Avoid graphs and charts unless they actually help understanding. If needed, make sure they are simple and clear.
- Balance the use of text, graphics, and clear or "white space." Try for 40-50% white space.
- Avoid using all capital letters. To show emphasis, use bold, larger type size or different fonts. Avoid italics of more than a few words at a time.
- When possible, use graphics or spell out fractions and percentages.

This information was used when selecting mHealth apps and when creating the best practice guide. Elements were selected and shared in the best practice guide and/or used to assess specific recommended apps. Critical elements that translated to smartphone mHealth app selection and implementation were a sixth grade reading level, appealing color scheme, logically structured material, easy fonts to read, effective use of graphics, avoidance of words with all capitalization, and the avoidance of graphs and charts that do not help with understanding. In contrast, font size values were less critical since font size on smartphones can be adjusted to personal needs and smartphones do not use multi-column format for text. Critical elements that translated into best practice guide creation were logically structured material, use of bulleted text or tabulated text, and consistency with terms.

## Mobile Health App Limitations and Barriers

Resources accessed to overcome limitations and barriers in this best practice guide came from Fletcher and Jensen (2015), Patrick et al. (2008), Scherr et al. (2009), Chiauzzi et al. (2015), and Kang and Park (2016). Mobile health apps should be accessible to all patient populations including the elderly, people with low literacy, and

people with permanent or temporary disabilities. Barriers and limitations usually seen with the elderly include:

- Negative attitudes and self-doubt in themselves to learn new technology. Assessment of an elderly's ability to use mHealth app is crucial. Sometimes encouragement is all that is needed.
- Elderly take more time navigating mHealth apps. To make it more user friendly, keep mHealth apps very simple with only one or two buttons to navigate.
- The consensus on tabulated research regarding elderly and mHealth apps was to keep menu options minimal, use color coding with yellow being the recommended color and avoiding blue, keep fonts at 14 points, and keep the activity with low complexity.
- Keep the brightness on smartphone at high.
- Elderly are concerned they have a lack of education on technology. Training should include lessons with an active exercise including complete instruction for each task and providing step-by-step assistance. For the elderly wanting to learn on their own, provide handouts with simple step-by-step instructions with screenshots.
- Elderly populations are very concerned about privacy issues regarding mHealth apps. It is recommended addressing their concerns with HIPAA privacy laws and using password protections.

The security concerns of elderly patients prompted the DNP candidate to emphasize the use of password protection on smartphones and avoid wireless

transmission of data to minimize the likelihood of breaches in security. In summary, the younger population is likely to be more flexible with the use of mHealth apps and is less impacted by app limitations and barriers. Elderly patients will be more sensitive to those limitations and barriers; they are more likely to adopt apps that are easy to use and have graphical displays with few details and high contrast for visibility. The best practice guide incorporated elderly needs into the recommendations.

Smartphone data plans and coverage are not particularly relevant when considering the use of mHeath apps; some patients may have very limited data plans not amenable to the transfer of data to healthcare clinics and some patients may also live in rural areas with limited service. Since mHealth apps chosen for this capstone do not transmit data and do not require service to run, data plans and coverage are not factors in the use of mHealth apps. The patient requires service only to download the mHealth app to the smartphone. Once downloaded, the mHealth app functions with or without connectivity to the outside world and does not consume data resources.

### What to Include and Not Include in Mobile Health Apps

Although it might seem trivial, instructions for the use of mHealth apps are paramount in mitigating risk. Three types of risks are associated with mHealth apps. The first type of risk is associated with mHealth apps that attempt to actively assist a patient by performing an action such as calculating or deriving some value the patient uses to control a chronic illness. For instance, an mHealth app that calculates an insulin dosage belongs to this type. Harm to the patient could result should the patient misuse the program or should the mHealth app compute an incorrect value. Another risk in this category is medication alarms that could distract a driver by an mHealth app. The

mHealth apps promoted in this capstone track patient data and do not pose risks of this type.

Mobile health apps associated with the collection and storage of data represent a different kind of risk. The purpose of the collected data is to enable the provider with measurement data to optimize treatment. Patients who collect incorrect data, either knowingly or unknowingly, will arm the provider with incorrect information and assist in the creation of a non-optimum treatment plan. Patients with improper education or limited skills might unknowingly collect and store bad data.

The last type of risk is associated with stolen use of stored data in mHealth apps. Electronic data are inherently transferrable to other devices and might occur without the patient's knowledge. For instance, a phishing virus could search data logs and transmit data to remote servers or data stored on company phones might be the property of the company and not the patient. The existence of data logs could present a problem if misused. For instance, a potential employer who gained access to data logs could rescind a job offer to prevent employing someone who would increase the cost of a company's health insurance plans. To minimize these risks, clear instructions and a clear set of best practices are necessary.

Mobile health apps should be able to store and display data relevant to the chronic illness of the patient. The selection of the mHealth app should depend on the nature and severity of the patient's chronic illness. A primary goal of mHealth app usage is better patient engagement and adherence. To this end, the ideal mHealth app should be one the patient likes. According to Cocosila and Archer (2005), Cho et al. (2014), NHS (2008), and Schmidt (2012), programs that perform a few functions well are more effective than

complex programs that perform many functions. The program should do what the patient needs and not have many extraneous features that detract from the program's core competency. The display should be pleasing to the patient and the ease or complexity of the program should agree with the desires and skillsets of the patients.

An important consideration is whether the mHealth app transmits data to a remote server or not. Data transmitted to the clinic's EHR system must be private under HIPAA (1996) laws. Providers should carefully weigh the need for transmitting data before using and allowing a mHealth app to transmit data to their EHR system. This best practice guide recommended against wireless transmission of data to the clinic's EHR system unless the known system is secure.

Many risks are associated with mHealth apps. Understanding the patient populations and their capabilities can greatly decrease issues associated with mHealth apps. The best practice guide reviewed risks and gave recommendations on ways to minimize or eliminate risks.

### Health Insurance Portability and Accountability Act/Legal Issues

Resources used for this category were collected from Yang and Silverman (2014), Bengtsson et al. (2014), and Lewis and Wyatt (2014). Security and HIPAA issues exist with the use of mHealth app technology. Many smartphones are set up with Cloud data storage, a concept that is still poorly understood by many people at this time. Cloud storage means data input into the smartphone are automatically stored somewhere in the vast storage capability of the internet. It is there for all of time and in principle, hackers could try to gain access to personal records. Many people are also naïve in their use of

password protection and smartphones with inadequate password protection could be stolen and mined for data.

Another consideration a patient should understand is any phone given to an employee to use for business is owned by the company. The company has the ability to scan the phone to see what information is stored on the phone. Therefore, any medical information stored on the phone could be viewed by the company. HealthIT.gov (2013) makes the following recommendations before downloading mHealth apps:

1. Research mobile applications (apps) before downloading;
2. Download at home on a secure Wi-Fi network;
3. Use a password on smartphone;
4. Do not install or use file-sharing applications;
5. Maintain physical control;
6. Delete all stored health information before discarding or reusing the mobile device;
7. Keep your security software up to date.

"Before you download and install an app on your mobile device, verify that it will perform only functions you approve of" (HealthIT.gov, 2013, Expression 1).

Instruction and partnering with patients is critical in the development of mHealth apps for chronic illness care. Patients represent a wide range of skill-sets and educational levels. For many patients, intuitive use of mHealth apps will suffice for data privacy and protection. For some patients, clear instruction is necessary for patient protection. In some cases, patients might not be able to grasp the inherent complexities and might not

be appropriate patients for mHealth apps. It is important that patients understand risks associated with mHealth app usage.

Mobile health apps are currently not regulated and do not need to adhere to regulations such as those created by HIPAA (1996). Due to legal issues associated with data transmission, the mHealth apps recommended in this research project do not upload data to a server for retrieval but rather store data locally or on the individual's Cloud storage account. Although smartphone carriers have been working to improve security, the basic security of smartphones against unwanted intrusion still needs improvement. For providers to retrieve data from smartphones, safeguards must be taken.

According to literature retrieved from Lewis and Wyatt (2014), the following recommendations are made to reduce the risk for potential HIPAA violations:

- Patients could bring their smartphones to the provider who could view the results directly on the smartphone screen.
- Patients might also print hard copies from home to bring to the clinic. The provider might view the hardcopy or scan the data into charts.
- Providers could download the data on the smartphones by making direct wire connections to secure computers at the clinic.
- Patients might capture a screenshot of data and email it to providers but should be aware that unsecured email might be vulnerable to hackers. HIPAA violations could occur.

E. Liprandi, a Senior Software Engineer at Snapfish LLC who has 15 years in developing computer software as well as mHealth apps was used as an expert consultant

for this project (E. Liprandi, personal communication, February 24, 2016). Mobile devices have made it convenient for many individuals to track their health.

Liprandi stated that convenience makes it easy to capture a lot of data. While apps and devices can record data points automatically for you, even the simple fact that individuals can capture a piece of information without having to reach for a health notebook or log into some application generates a lot more data. And while those data are intended to be used for good, they can also be used against the individual. Liprandi listed simple steps individuals can take to address some of those risks: only use services from providers you trust, always check the reviews, take a few minutes to read the reviews, and assess the need to enter identifiable information for any service. Most providers should not need a patient's street address, social security number, or credit card information to use a mHealth app (Liprandi, personal communication, February 24, 2016).

The information provided above was used in the best practice guide. The best practice guide also included handouts for the patient to review mHealth apps before downloading. The more information given to patients, the more likely they will accept the new technology to help them with their chronic illness.

## Ranking of Mobile Health Apps

Cocosila and Archer (2005) studied patient compliance with regard to app complexity and pointed out facilitators and barriers to long-term adherence. They argued for the reinforcement of both positive and negative attitudes based on details of the graphical user interface and ease of data entry. Instantaneous feedback promoted positive attitudes and encouraged patients to continue using the app. They also defined a ricochet

effect whereby too much tedious data entry would discourage end users from long-term adherence to app usage.

Numerous mHealth apps for monitoring chronic illnesses have been created. This evidence-based plan focused on HTN as the example and used the mHealth app that monitors BP input. Many mHealth apps are quite good, are free, and have similar capabilities and similar rankings. Mobile health apps are inherently easy to write with high-level programming languages replete with widgets for graphical user interface creation.

Using the literature previously mentioned, the mHealth app was evaluated on a three dimensional scale by the author of this capstone project. The three dimensions incorporating the aforementioned concepts were simplicity, usability, and the display. The simplicity dimension incorporated a focus on the program's core strength without extraneous information and functionality that did not benefit the patient. The usability dimension incorporated easy data entry and display as well as easy navigation through the program. The display dimension incorporated a pleasing graphical display with pleasant colors and a legible font. A number was given for each dimension if the mHealth app achieved the following:

Simplicity: 0 = Not achieved, 1 = Good, 2 = Great

Usability: 0 = Not achieved, 1 = Good, 2 = Great

Display: 0 = Not achieved, 1 = Good, 2 = Great

Of note was free mHealth apps often have advertising to cover costs and make profits for the creators. Advertising might be annoying to many patients but could be a

reasonable trade-off for a free app. The mHealth apps chosen had no association with the author of the capstone or any of its committee chairs.

**Smart Blood Pressure as an Exemplar Mobile Health Application**

*Figure 3.* Smart blood pressure tracker for Android/iPhone (Evolve Medical Systems, LLC, 2016).

The SmartBP app had an overall score of 3: 1 for simplicity, 1 for usability, and 1 for display. This app was easy to record. It was also easy to navigate with 1 1 touch button on the homepage. Issues this DNP candidate did not like was the "history" button was very close to the "share" button, which could be easy for patients with large fingers or dexterity problems to hit inadvertently. Also numbers such as weight and birthday were entered with a scroll bar and would be hard to navigate for those with limited vison, inadequate dexterity, and large fingers. The "history" display was messy and not very visually appealing. Roth and Cherney (2015) gave this app a rating of four stars. Figure 4 provides screen shots of the app.

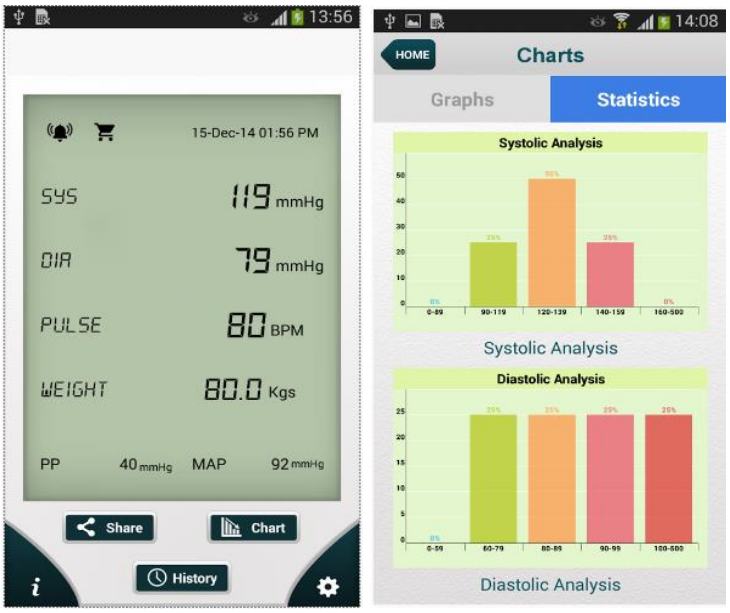


*Figure 4.* Screen shots of the smart blood pressure tracker app.

## Survey Results

The best practice guide was created and presented to the family practitioners at a local clinic. Other presentations were done informally over breakfast to providers who did not have support to hold presentations at their healthcare facility. Still other presentations were provided at one-on-one sessions in the homes of local providers. After listening to the presentation, the participants took part in a Qualtrics questionnaire to provide feedback on the content, quality, and presentation of the best practice guide (see Appendix A). The results of the questionnaire are presented in Figures 5 through 23.

**1. Before reviewing the Capstone project information and best practice guide, were you knowledgeable about the usage of mHealth apps to aid in the treatment of patients with chronic illnesses?**

| Comments |
| --- |
| Aware of some apps but limited |
| I knew they existed |

| Answer | Bar | Response | % |
| --- | --- | --- | --- |
| Extremely knowledgeable | | 4 | 33.33% |
| Decline to answer | | 0 | 0.00% |
| Not knowledgeable | | 6 | 50.00% |
| Decline to answer | | 2 | 16.67% |
| Click to write Choice 6 | | 0 | 0.00% |

*Figure 5.* Responses and comments regarding question 1 of the survey.

**2. Does your clinical practice have a best practice guide in place for the usage of mHealth apps?**

| Comments |
| --- |
| At present being developed, however with this additional resource thru Laurie Niles, RN Best Practice Guide we will certainly utilize this resource. |

| Answer | Bar | Response | % |
| --- | --- | --- | --- |
| Yes | | 0 | 0.00% |
| Don't Know | | 1 | 8.33% |
| No | | 10 | 83.33% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 1 | 8.33% |

*Figure 6.* Responses and comments regarding question 2 of the survey.

**3. Do you believe that the majority of your patients have the necessary skills to use mHealth apps to participate in their treatment plans?**

| Comments |
| --- |
| More and more patients here at ROCKY MOUNTAIN FAMILY PHYSICIANS are becoming more computer literate. |

| Answer | Bar | Response | % |
| --- | --- | --- | --- |
| Comments | | 1 | 8.33% |
| Yes | | 10 | 83.33% |
| Don't Know | | 1 | 8.33% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |

*Figure 7.* Responses and comments regarding question 3 of the survey.

**4. Did the provided Capstone information and best practice guide educate you on how the mHealth apps could inform your treatment plans?**

| Comments |
| --- |
| Well written and instructive for patients |

| Answer | Bar | Response | % |
| --- | --- | --- | --- |
| Yes | | 11 | 91.67% |
| Undecided | | 0 | 0.00% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 1 | 8.33% |

*Figure 8.* Responses and comments regarding question 4 of the survey.

**5. Did the provided Capstone information and best practice guide give you adequate information to make recommendations for the selection of mHealth apps for patients with chronic illnesses?**

**Comments**

Absolutely

| Answer | Bar | Response | % |
|---|---|---|---|
| Yes | | 10 | 83.33% |
| Undecided | | 1 | 8.33% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 1 | 8.33% |

*Figure 9.* Responses and comments regarding question 5 of the survey.

**6. Did the provided Capstone information and best practice guide inform you on features that mHealth apps should include and not include?**

**Comments**

| Answer | Bar | Response | % |
|---|---|---|---|
| Yes | | 11 | 91.67% |
| Undecided | | 1 | 8.33% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 0 | 0.00% |

*Figure 10.* Responses and comments regarding question 6 of the survey.

**7. After reviewing the Capstone project information and best practice guide, do you feel comfortable introducing mHealth apps to patients?**

| Comments |
| --- |
| Absolutely |

| Answer | Bar | Response | % |
| --- | --- | --- | --- |
| Yes | | 8 | 72.73% |
| Undecided | | 2 | 18.18% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 1 | 9.09% |

*Figure 11.* Responses and comments regarding question 7 of the survey.

**8. After reviewing the Capstone project information and best practice guide, do you feel that you have enough information to address health literacy in addition to general literacy issues with patients regarding mHealth app use?**

| Comments |
| --- |
| Each day more and more information is coming forward regarding health care management for multiple simple and complex health care issues. |

| Answer | Bar | Response | % |
| --- | --- | --- | --- |
| Yes | | 10 | 83.33% |
| Undecided | | 1 | 8.33% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 1 | 8.33% |

*Figure 12.* Responses and comments regarding question 8 of the survey.

**9. After reviewing the Capstone project information and best practice guide, do you feel comfortable reviewing data collected by patients using mHealth apps?**

**Comments**

| Answer | Bar | Response | % |
|---|---|---|---|
| Yes | | 11 | 91.67% |
| Undecided | | 0 | 0.00% |
| No | | 0 | 0.00% |
| Decline to answer | | 1 | 8.33% |
| Comments | | 0 | 0.00% |

*Figure 13.* Responses and comments regarding question 9 of the survey.

**10. After reviewing the Capstone project information and best practice guide, do you understand the limitations and barriers of mHealth apps?**

**Comments**

| Answer | Bar | Response | % |
|---|---|---|---|
| Yes |  | 11 | 91.67% |
| Undecided |  | 1 | 8.33% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 0 | 0.00% |

*Figure 14*. Responses and comments regarding question 10 of the survey.

**11. After reviewing the Capstone project information and best practice guide, do you understand the legal issues associated with mHealth app usage?**

**Comments**

| Answer | Bar | Response | % |
|---|---|---|---|
| Yes | | 11 | 91.67% |
| Undecided | | 1 | 8.33% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 0 | 0.00% |

*Figure 15.* Responses and comments regarding question 11 of the survey.

**12. After reviewing the Capstone project information and best practice guide, do you think the benefits outweigh the risks of mHealth apps in the treatment of patients with chronic illnesses?**

**Comments**

| Answer | Bar | Response | % |
|---|---|---|---|
| Yes |  | 11 | 91.67% |
| Undecided |  | 1 | 8.33% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 0 | 0.00% |
| No | | 0 | 0.00% |

*Figure 16.* Responses and comments regarding question 12 of the survey.

**13. Do you agree with the best practice guide recommendations?**

**Comments**

| Answer | Bar | Response | % |
|---|---|---|---|
| Yes | | 12 | 100.00% |
| Undecided | | 0 | 0.00% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 0 | 0.00% |

*Figure 17.* Responses and comments regarding question 13 of the survey.

**14. Were any key points missing regarding mHealth apps in this presentation?**

**Comments**

| Answer | Bar | Response | % |
|---|---|---|---|
| Yes | | 1 | 8.33% |
| No | | 11 | 91.67% |
| Decline to answer | | 0 | 0.00% |
| Comments | | 0 | 0.00% |
| Undecided | | 0 | 0.00% |

*Figure 18.* Responses and comments regarding question 14 of the survey.

**15. After reviewing the Capstone project information and best practice guide, are you more inclined to consider adopting mHealth apps to aid in the treatment of patients with chronic illnesses?**

| Comments |
| --- |
| RMFP will certainly utilize the mHEALTH APPLICATIONS for our chronic patients. |

| Answer | Bar | Response | % |
| --- | --- | --- | --- |
| Comments | | 1 | 8.33% |
| Yes | | 11 | 91.67% |
| Undecided | | 0 | 0.00% |
| No | | 0 | 0.00% |
| Decline to answer | | 0 | 0.00% |

*Figure 19.* Responses and comments regarding question 15 of the survey.

**16. My goal for the Capstone project was to address key points of mHealth apps usage to enable adoption in clinical settings. Did the capstone project information and best practice guide achieve that goal for: (Choose all that apply)**

| Answer | Bar | Response | % |
|---|---|---|---|
| What to include and not to include in mHealth apps. | | 9 | 81.82% |
| How to select mHealth apps. | | 10 | 90.91% |
| When to use mHealth apps. | | 10 | 90.91% |
| How to introduce mHealth apps to patients with chronic illnesses. | | 11 | 100.00% |
| How to use mHealth apps. | | 10 | 90.91% |
| How to instruct patients on mHealth usage who have limited mHealth and general literacy | | 10 | 90.91% |
| Understand the legal issues. | | 10 | 90.91% |
| Understand the limitations and barriers. | | 10 | 90.91% |

*Figure 20.* Responses to question 16 of the survey.

| 17. What reason(s) would inspire you to adopt mHealth technology for patients with chronic illnesses? |
| --- |
| Up to date medical info and patient and medical provider can track progress or when there is concern |
| To keep track chronic issues through daily living. |
| Positive patient response to their usefulness. |
| Patient engagement |
| Engaging patients |
| Motivation of pts to use |
| Better patient engagement will really help treatment plans. |
| Primary reason is the improved patient engagement through mHealth app use. |
| Help monitor and manage chronic illnesses. |

*Figure 21.* Responses to question 17 of the survey.

**18. What else would you like to know about mHealth apps that you did not see in the Capstone project or the best practice guide?**

| Text Entry |
| --- |
| I believe the presentation was complete with the present day health care chronic needs. |
| I feel I learned a lot. I would like to use these apps. |
| Unable to say now. |
| Coveted thoroughly |
| NOne |
| The best practice guide was thorough. It gave me a good overview of what to look for. |
| Project was well constructed and organized. Laurie was very confident in the delivery. |
| Tutorials to help patients in the future. |
| Very complete. |

*Figure 22*. Responses to question 18 of the survey.

**19. Please provide any feedback you have regarding mHealth apps, the Capstone project information, and best practice guide.**

| Text Entry |
| --- |
| Great presentation...Very Timely Information and guide lines for management of Chronic Care Patients |
| Thorough and well done |
| Great job. |
| Well covered |
| None |
| Laurie really gave an excellent presentation. |
| Great information. Concise and easy to understand. This capstone really encouraged me to take mHealth apps more seriously. |
| Well done. |
| Great info |
| Great information. Very complete guide. |

*Figure 23.* Responses to question 19 of the survey.

Twelve people provided responses to the questionnaire. With only 12 respondents, each individual respondent contributed 8% to the score for each question. Since a single respondent changing an answer would change the score by 8%, one needs to be careful when interpreting scores. Furthermore, when any respondent provided a comment, the multiple choice answers were no longer counted in the results due to the way the Qualtrics software handles responses to questions. The responses clearly show

the value of a best practice guide. Although 33% of respondents were knowledgeable about mHealth apps, none of the 12 respondents indicated that they knew the clinic had a best practice guide. One respondent commented that a best practice guide was in progress and this project would accelerate completion of it. With regard to implementation, 83.3% of the respondents believed patients had the ability to use a mHealth app, 8.3% believed computer literacy was increasing rapidly, and 8.3% did not know. The three questions targeted toward understanding the educational quality of the best practice guide were all greater than 90% positive.

Of these positive responses, only 82% of the respondents felt comfortable recommending mHealth apps and felt they had sufficient literacy on mHealth apps to work with patients, 92% thought the benefits of mHealth app adoption outweighed the risks, but 100% agreed with the recommendations of the best practice guide. During the presentation by the DNP, all respondents provided positive feedback and none indicated any missing features. One respondent indicated in the questionnaire that a key point was missing in the presentation but did not give any details. The reason was unclear but possibly could be due to the respondent simply not liking mobile technology, not wanting to see it adopted in the medical field, or not wanting change due to retirement within the year. This respondent illuminated a key barrier to the deployment of technology. Thus, when promoting technology in family practices, one should consider the possibility that some providers and patients might not want to develop solutions based on electronic technology.

Several questions were designed to gain an understanding of the benefit of a best practice guide. The presentation was meant to educate them on the growing popularity of

mHealth apps. After the presentation, the consensus for the knowledge was they learned more about what should be included, security risks, and reviewing apps before suggesting an mHealth app to their patients. The majority of the providers responded positively to recommending mHealth apps to their patients with only one respondent indicating "don't know." Best practice is clearly needed and wanted by the providers involved in this presentation.

## Summary

Feedback on the creation and implementation of a best practice guide for using mHealth apps was positive. The respondents on the questionnaire indicated patient engagement was the primary driving force for mHealth app adoption although the ability to improve patient data was also important. The current state of the art that maximizes patient benefits while minimizing risk is the use of mHealth apps to track parameters associated with chronic illnesses. The medical industry is clearly eager to work with mHealth technology to improve treatment plans for chronically ill patients.

# CHAPTER V

# RECOMMENDATIONS

## Recommendations

The best practice guide presentation to local northern Colorado providers was received positively. Feedback supported the argument that mHealth app adoption would be an asset to treatment plans for patients with chronic illness and that mHealth app adoption was impeded by the lack of a best practice guide to accelerate learning. Providers felt patients were sufficiently savvy with technology to make effective use of mHealth apps. Primary barriers to implementation were a lack of knowledge about the evidence-based benefits of mHealth usage and a methodology to select mHealth apps.

The best practice guide document was also received positively. The level was appropriate to serve as a primer for implementation of mHealth apps. Mobile health app usage is still in its infancy and the technology will experience change in the immediate future and possibly mature in the extended future. The best practice guide for this capstone was written with the intention of showing providers and patients how to find information needed to make informed decisions with respect to mHealth technology, not a comprehensive list of apps to recommend for their patients or tutorials for patient app utilization.

Specific details of mHealth apps in this capstone pertained to the state of the art at the time of writing. With the rapid development of mHealth technology, this capstone

could not address future capabilities of mHealth apps. Using the exemplar of hypertension for instance, one can envision a mHealth app with the ability to pair the smartphone to a "smart sphygmomanometer" that records blood pressure without requiring a person to read a dial-based pressure gauge. The recommendations of this capstone would be compromised if they contained only specific analysis of mHealth apps on the market today and did not account for future development. To this end, the recommendations of this capstone are general in nature. With many new mHealth apps entering the market daily, providers must develop skills to find and implement effective mHealth apps based on evidence, the needs of the patient, and the capabilities of mHealth apps at the time of implementation.

What will remain constant in the rapidly developing arena of mHealth technology are the benefits of mHealth apps for treatment plans of patients with chronic illness. First, mHealth apps provide a more complete picture of a patient's condition by providing more data from outside the clinic. Second, mHealth apps promote patient engagement by providing a source of concrete actions for patients to perform. Third, mHealth apps facilitate self-care monitoring within the MRTScSI. These three evidence-based benefits will remain true in the future and present the framework for choosing mHealth apps for patients.

Recommendations for providers to make effective use of mHealth apps in clinical practice are as follows:

- Acknowledge the benefits of mHealth apps for patients with chronic illnesses,
- Recognize the technology is not yet mature and changes will be constant,

- Realize many new mHealth apps enter the market regularly,
- Understand security issues and make conservative plans,
- Follow the Health Information and Management Systems Society.
- Browse clearinghouses for mHealth app reviews,
- Encourage office-talk about mHealth apps,
- Understand that younger generations are much more strongly connected with mobile technology than older generations and leverage this connection to stay abreast of the field,
- Understand that as younger patients age and develop chronic illness, they will bring with them an affinity toward mHealth apps.

The results of the questionnaire led to at least two recommendations for future work. The first recommendation is a polished best practice guide suitable for national dissemination is needed. The results of the questionnaire showed a barrier to implementation was simply the steepness of the learning curve-- providers must develop a working knowledge of mHealth apps before recommendation and learning takes time and energy away from patient care. A best practice guide designed for accelerated learning and written in a format designed for national publication could be a valuable tool for providers across the country. Continued work on the best practice guide with the goal of publishing in a peer-reviewed journal is a natural extension of this capstone.

The second recommendation would be to evaluate the efficacy of a best practice guide to accelerate the adoption of mHealth app technology. The idea here is providers who have access to a best practice guide should be more amenable to recommending mHealth apps to patients. Therefore, the adoption of mHealth apps for providers who

have access to a best practice guide should exceed the adoption for providers who do not have access to a best practice guide. The execution of a case study between practices to compare the rate of adoption of mHealth apps with and without access to a best practice guide could ferret out the efficacy of the best practice guide to accomplish its purpose. The respondents to the questionnaire generally were aware of mHealth apps but did not use them in practice. A natural conclusion is they did not fully understand the value of mHealth apps and had not developed a system to select and implement them in practice. Such a case study would enable research nurses to quantify the added value of a best practice guide in mHealth adoption to providers.

## Implications for Practice

This particular choice of capstone topic was germane to primary care practice. Mobile health apps exist for nearly all chronic illnesses and many patients can benefit from their implementation. Most notably, the preventive care landscape is currently in a state of change with the aging of the American population, the adoption of nationalized healthcare, the consolidation of hospitals and clinics into corporate America, the changing educational requirements for clinical providers, the burgeoning of mobile technology, the constant pressure to minimize costs, and the rapid accumulation of evidence-based knowledge for chronic illness treatment. Healthcare providers can fold mHealth app technology nicely into this landscape, providing an inexpensive and proven method to improve treatment plans for nearly any patient with a chronic condition. Mobile health apps will be an important component to clinical practice for the author of this capstone.

## Contribution Toward Personal Goals

This capstone project was equally germane to the author of this capstone and her personal goals. In particular, the author of this capstone has enjoyed mobile technology for years and gravitates toward mobile solutions to many problems. A personal goal of the author is to play a leading role in the utilization of technology and mHealth apps in primary care practice as a family nurse practitioner. To this end, this author expects to develop and execute quality initiatives for mHealth app usage in family practice settings.

Before completing this capstone, the author expected the primary benefit of mHealth app technology was to provide better data for patient care. Work on this capstone expanded that view to incorporate improved patient engagement and improved self-care monitoring. The author plans to continue learning about mHealth apps and capabilities to help providers embrace their future in clinical practice in addition to actively using them within her own clinical practice.

## Summary

Smartphone ownership has become almost universal in America. Mobile health app adoption on smartphones has become an inexpensive method to add a fundamentally new dimension to treatment plans for chronically ill patients. Mobile health apps cannot replace providers and do not provide an alternative to effective provider engagement. They are high-technology tools for improving treatment plans. Still in its infancy, mHealth technology is expanding more rapidly in the general population than in clinical settings due to barriers to implementation. A best practice guide presented in this capstone is a tool for reducing those barriers by providing a concise document of relevant information needed for a clinical provider to research, select, and implement a mHealth

app in the treatment plan of a chronically ill patient and accelerate adoption of mHealth apps in clinical settings.

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# APPENDIX A

# QUESTIONNAIRE


*Informational Letter*

*Project Title: A Best Practice Guide for the Usage of mHealth Applications*

*Author: Laurie Niles, RN; University of Northern Colorado, Doctoral Student of Nursing*
*E-mail: nile4424@bears.unco.edu*
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*Research Advisor: Rhonda Squires, Ph.D. Department of Nursing*
*University of Northern Colorado*
*Rhonda.Squires@unco.edu*
*Phone: 970-351-2293*
*Fax: 970-351-1707*

*Purpose and Description: The purpose of this capstone is to develop a best practice guide for the usage of mHealth applications (mHealth apps) to aid in the care of patients with chronic illnesses using an exemplar of hypertension (HTN).*

*This survey has been sent to you, with the assistance of the nursing program department chairs, as an optional opportunity to assist in a project that may help target areas of improvement and further development of a best practice guide for the usage of mHealth applications for patients with chronic illnesses. At this time there is no best practice guide for the usage of mHealth applications.*

*This study has been approved under the exempt review from the course faculty through the University of Northern Colorado. Data collected and analyzed for this project will be accessed only by the author of this project in a private password-protected Qualtrics® account and all answers are anonymous to the author of this project.*

*There are no costs for participating in this capstone project other than the time invested to review this consent information and complete the survey. The survey can be completed in under 5 minutes. No compensation will be provided for the completion of this survey. The DNP candidate does not foresee any risks in providing feedback on this capstone project.*

*Participation is voluntary. You may decide not to participate in this project. If you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected. Having read the above and having had an opportunity to ask any questions, please sign below if you would like to participate in this project. A copy of this form will be given to you to retain for future reference. If you have any concerns about your selection or treatment as a volunteer participant in this project, please contact Sherry May, IRB Administrator, Office of Sponsored Programs, 25 Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910.*

*By completing this survey you have consented to be in the study.*

Q1

Before reviewing the Capstone project information and best practice guide, were you knowledgeable about the usage of mHealth apps to aid in the treatment of patients with chronic illnesses?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q2

Does your clinical practice have a best practice guide in place for the usage of mHealth apps?

- ○ Yes
- ○ Don't Know
- ○ No
- ○ Decline to answer
- ○ Comments

Q3

Do you believe that the majority of your patients have the necessary skills to use mHealth apps to participate in their treatment plans?

- ○ Yes
- ○ Don't Know
- ○ No
- ○ Decline to answer
- ○ Comments

Q4

Did the provided Capstone information and best practice guide educate you on how the mHealth apps could inform your treatment plans?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q5

Did the provided Capstone information and best practice guide give you adequate information to make recommendations for the selection of mHealth apps for patients with chronic illnesses?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q6

Did the provided Capstone information and best practice guide inform you on features that mHealth apps should include and not include?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q7

After reviewing the Capstone project information and best practice guide, do you feel comfortable introducing mHealth apps to patients?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q8

After reviewing the Capstone project information and best practice guide, do you feel that you have enough information to address health literacy in addition to general literacy issues with patients regarding mHealth app use?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q9

After reviewing the Capstone project information and best practice guide, do you feel comfortable reviewing data collected by patients using mHealth apps?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q10

After reviewing the Capstone project information and best practice guide, do you understand the limitations and barriers of mHealth apps?

- Yes
- Undecided
- No
- Decline to answer
- Comments

Q11

After reviewing the Capstone project information and best practice guide, do you understand the legal issues associated with mHealth app usage?

- Yes
- Undecided
- No
- Decline to answer
- Comments

Q12

After reviewing the Capstone project information and best practice guide, do you think the benefits outweigh the risks of mHealth apps in the treatment of patients with chronic illnesses?

- Yes
- Undecided
- No
- Decline to answer
- Comments

Q13

Do you agree with the best practice guide recommendations?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q14

Were any key points missing regarding mHealth apps in this presentation?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q15

After reviewing the Capstone project information and best practice guide, are you more inclined to consider adopting mHealth apps to aid in the treatment of patients with chronic illnesses?

- ○ Yes
- ○ Undecided
- ○ No
- ○ Decline to answer
- ○ Comments

Q16

My goal for the Capstone project was to address key points of mHealth apps usage to enable adoption in clinical settings. Did the capstone project information and best practice guide achieve that goal for: (Choose all that apply)

- ☐ What to include and not to include in mHealth apps.
- ☐ How to select mHealth apps.
- ☐ When to use mHealth apps.
- ☐ How to introduce mHealth apps to patients with chronic illnesses.
- ☐ How to use mHealth apps.
- ☐ How to instruct patients on mHealth usage who have limited mHealth and general literacy
- ☐ Understand the legal issues.
- ☐ Understand the limitations and barriers.

Q17

What reason(s) would inspire you to adopt mHealth technology for patients with chronic illnesses?

Q18

What else would you like to know about mHealth apps that you did not see in the Capstone project or the best practice guide?

Q19

Please provide any feedback you have regarding mHealth apps, the Capstone project information, and best practice guide.

**A Best Practice Guide for Usage of mHealth Applications**

# APPENDIX B

# STATEMENT OF MUTUAL AGREEMENT

Statement of Mutual Agreement
University of Northern Colorado
Doctorate of Nursing Practice Capstone Project
Laurie Niles
April 13, 2016

The purpose of the "Statement of Mutual Agreement" is to describe the shared view between the volunteer providers, capstone chairs and Laurie Niles, DNP Candidate from the University of Northern Colorado, concerning her proposed capstone project.

**Proposed Project Title:** A Best Practice Guide for the Usage of mHealth Applications

**Brief Description of the Proposed Project:** The purpose of this capstone is to develop a best practice guide for the usage of mobile health applications (mHealth apps) to aid in the care of patients with chronic illnesses using an exemplar of hypertension (HTN). One piece missing in the widespread deployment of mHealth apps is a best practice guide. Mobile phone applications have expanded rapidly as mobile phone technology has captured the attention of the American society. The medical community participates in mobile phone technology through mHealth apps. Usage of mHealth apps has both inherent benefits and risks. The primary benefits of mHealth apps is the ability to engage patients in self-care activities and to track data at regular intervals during the day without resorting to paper data collection. The primary risk of mHealth apps is the possible violation of Health Insurance Portability and Accountability Act (HIPAA) laws with technology that has not yet been adequately regulated by appropriate authorities.

Mobile phone technology has proven to be far more useful than basic paper data collection. Data shows that the use of mHealth apps for tracking data such as BP measurements, engages patients in their treatment plans and empowers them to advocate for themselves. This empowerment adds a new dimension to the patient-provider relationship and to treatment plans. mHealth apps give patients concrete actions to perform which promotes adherence to treatment plans and activities that foster long-term health.

Although mobile phone technology is mature and widespread, the healthcare community has not fully exploited it as an aid in the treatment of patients with chronic illnesses. This capstone focuses on the development of a best practice guide for the usage of mHealth apps and to facilitate deployment of mHealth apps into clinical settings. It will serve as a practical best practice guide for a DNP to understand the capabilities of mHealth apps to reduce the effects of chronic illnesses and the benefits and risks associated with the usage of mHealth apps.

**Goal of this Capstone Project:** The goal of this project is to provide a best practice guide for use of mHealth apps by providers in the clinical setting to enhance patient care for those suffering with chronic illnesses.

**Proposed On-site Activities:** The best practice guide is to be used by the clinical providers rather than patients with chronic illnesses. The volunteer providers include seven healthcare providers. The DNP candidate will present the created best practice guide during an informal break at a local family clinic. At the conclusion of the presentation, the DNP candidate will disseminate a website address for a Qualtrics® questionnaire for the volunteers provide feedback on the presentation and the best practice guide. Responses will be collected in an anonymous format on the Qualtrics® website to protect the privacy of the volunteer providers.

**Confidentiality of Patient Records:** Patient records and personal information will not be used for this project.

The designated Capstone Community/Agency member will agree to participate in the review and approval of the proposal and presentation of the final version of the project. She will attend (either on campus or remotely) the meetings for both.

The DNP Capstone project will include a final report, an abstract, a potential publication or an oral presentation of the report. No personal identifiers will be included and all data will be reported in aggregate form. The Author welcomes any comments or suggestions from the Agency, but reserves the right to publish findings and analysis according to professional standards and principles of academic freedom. For any work of a scholarly nature, the Author agrees to follow the Agency preferences in how it is to be named (or not) in the work.

Janine Niles 4-12-16

Signature of Student Date

Richard L McMullin Administrator/Manager 4/13/2016

Signature of Agency Member Date

Rhonda D Squires 4-13-16

Signature of Capstone Chair Date

# APPENDIX C

# INSTITUTIONAL REVIEW BOARD APPROVAL

UNIVERSITY OF
NORTHERN COLORADO

*Institutional Review Board*

| | |
|---|---|
| DATE: | April 18, 2016 |
| TO: | Laurie Niles |
| FROM: | University of Northern Colorado (UNCO) IRB |
| PROJECT TITLE: | [892877-1] A Best Practice Guide for Usage of mHealth Applications |
| SUBMISSION TYPE: | New Project |
| ACTION: | APPROVAL/VERIFICATION OF EXEMPT STATUS |
| DECISION DATE: | April 16, 2016 |
| EXPIRATION DATE: | April 16, 2020 |

Thank you for your submission of New Project materials for this project. The University of Northern Colorado (UNCO) IRB approves this project and verifies its status as EXEMPT according to federal IRB regulations.

We will retain a copy of this correspondence within our records for a duration of 4 years.

If you have any questions, please contact Sherry May at 970-351-1910 or Sherry.May@unco.edu. Please include your project title and reference number in all correspondence with this committee.

# APPENDIX D

# BEST PRACTICE GUIDE

# A BEST PRACTICE GUIDE FOR THE USAGE OF MOBILE HEALTH APPLICATIONS

Laurie Fridley Niles

University of Northern Colorado

# Table of Contents

**Unit 1: Introduction to mHealth**

**"A Best Practice Guide for the Usage of mHealth Applications"** is a practical guide to help providers and patients incorporate mobile health (mHealth) applications (apps) into the treatment plans of patients with chronic illnesses. mHealth apps are programs written for mobile devices such as smartphones that can assist patients with management of the symptoms of chronic illnesses. mHealth apps are the way of the future. mHealth apps can provide an exciting and dynamic component to treatment plans, providing patients with a method to help providers develop better treatment plans. The fundamental premise of this guide is to educate providers on the benefits and risks of adding mHealth apps into their treatment plans. It is meant to be a "How-To" guide to speed learning and adoption of mHealth apps.

mHealth (common phrase) is a term generated by the Healthcare Information Management Systems Society (HIMSS; 2016) to define a combination of modern information technology with evidence-based health practice. mHealth technology is expanding rapidly, creating new opportunities for health care providers to support self-management behavior for patients. mHealth apps improve treatment plans in three ways:

- mHealth apps empower patients to understand their chronic illnesses better

- mHealth apps allow patients to provide better clinical information to their providers
- mHealth apps allow patients to self-manage their chronic illness

According to studies (Goh et al., 2015; Lopez, Seville, & Javitt, 2012; Patrick, Griswold, Raab, & Intill, 2008), mHealth apps provide benefit in the treatment plans of patients with many chronic illnesses, and may include:

- Asthma
- Crohn's Disease/IBS/IBD
- Depression
- Diabetes
- Dietary Intake
- Eczema
- Fitness Programs
- Health/Medication History
- Hypertension
- Insomnia/Sleep Issues
- Pain - Chronic
- Renal Disease
- Rheumatoid Arthritis
- Skin

**Unit 2: When to Use mHealth Apps**

mHealth apps are suitable for chronic illness management rather than recovery from acute medical events. Acute events include heart attacks, strokes, lacerations, seizures, broken bones, etc. They require urgent attention from trained medical professionals for proper management and recovery. mHealth apps are designed for chronic illness management, education and tracking. Consider hypertension as the exemplar. How will the patient respond to blood pressure measurements that do not have a reasonable level of control? A high measurement could cause stress that would exacerbate the condition, and result in excessive calls to the clinic. A high measurement could, however, be a needed warning to the patient to work diligently to gain control over blood pressure.

The provider should carefully consider the desires, the emotional state and the skillset of the patient before recommending a mHealth app. Not all patients are suited to mHealth app usage. According to Fletcher and Jensen (2015), patients with negative attitudes for technology are likely to resist the usage of mHealth apps. Patients who draw inappropriate conclusions from input data and act on them would not be good candidates for mHealth app usage. An obese patient who is not ready to lose weight would not be a good candidate for a fitness tracking mHealth app.

Providers should also be wary of patients who may overrate the capabilities of mHealth apps, and assume that the mHealth app is an inexpensive replacement for patient

care from a professional provider. For instance, the mHealth app, SkinVision (SkinVision B.V., 2015), tracks skin changes for early detection of skin cancer by comparing successively captured images of moles, lesions, or growths and comparing the sizes and colors. As a tracking device, SkinVision has merit, but patients should never rely on such measurements to determine the need or lack of need to properly diagnose and treat skin changes.

Cho et al. (2014) in a study regarding motivation for use of a mHealth app reported that the younger population and the more highly educated population are more proficient with mHealth app use. The report also suggested that men appear to be more health conscious and to have more skills with health apps. Also noted was that more intricate mHealth apps were less likely to have long term use. The more an app is used by a patient the more likely the patient will continue to use it. The study concluded the need for providers to keep chosen apps simple with minimal steps for inputting and viewing data.

According to Cho et al. (2014), successful usage of mHealth apps will come from young or technically savvy patients. Other successful patients include those who are ready to ameliorate the symptoms of their chronic condition, have an appreciation for the limits and the benefits of technology and are sufficiently skilled to take accurate measurements and input correct data. Good candidates will understand that the mHealth

app does not do the work of the provider, and does not replace the diligence required of them to improve their condition.

**Table 1. Chronic Illness and Suggested Capabilities of the mHealth Apps**

| ***Chronic Illness*** | ***Proposed Application of a mHealth App*** | ***Possible Data Collection*** | ***Exemplar App*** |
|---|---|---|---|
| Asthma | · Patient can track exacerbations:<br>- Severity of asthma at time?<br>- Environmental factors?<br>- Activities at time? | · Did patient use a rescue inhaler, if so, how many times?<br>· How were the patient's ADLs affected? | **App: AsthmaMD** (Pejham, 2016)<br>· Easy for patients to log asthma attacks.<br>· The app has the ability to customize triggers and medications for quicker entry.<br>· At-a-glance, graphical view of patient's PFM and severity.<br>· Creation of action plans<br>· Cost $0 |
| Crohn's/Colitis/IBD/IBS | · Patient can track exacerbations.<br>· Patient can track activities when symptoms appeared?<br>· What were the environmental factors at time of exacerbation?<br>· What was patient's pain level at time of exacerbation? | · What medications did the patient use?<br>· How were the patient's ADLs affected? | **App: GI Buddy** (Crohn's & Colitis Foundation of America, 2015)<br>· Helps patients track symptoms, treatments, and diet<br>· Ability to check data by week, month, or year to detect possible patterns<br>· Cost $0 |
| Depression | · Log Patients moods with:<br>- Activity<br>- Medications<br>- Exercise | · What medications did the patient use?<br>· How were the patient's ADLs affected? | **App: NIH Depression Info** (Incelligence, 2011)<br>· Includes detailed information about symptoms, causes, diagnosis, and treatments for the condition<br>· Find information about how patient can look for help if patient has sign of depression<br>· Cost $0 |
| Diabetes | · Log Patients blood sugar with:<br>- Activity<br>- Food<br>- Bolus<br>- Mood<br>- Symptoms | · What medications did the patient use?<br>· How were the patient's ADLs affected? | App: Diabetes Logbook **(mySugr GmbH, 2016)**<br>·Diabetes management for the gamified generation to track and log blood sugar<br>· Colorful easy-to-read screens<br>App: Diabetik **(UglyApps, 2016)**<br>· Reminders alert for appointments<br>· Reminders for medication times based on patient's preset information<br>· Cost $0 |

| | | | |
|---|---|---|---|
| Dietary Intake | Keep diary of:<br>- Carbohydrates<br>- Proteins<br>- Fats<br>- Potassium<br>- Sodium<br>- Sugars<br>- Gluten | · How well did the patient tolerate diet?<br>· How were the patient's ADLs affected? | **App: MyFitnessPal** (2016)<br>· Large food database<br>· Restaurant database<br>· Track**s** overall calorie intake including sodium intake, your vitamin intake, cholesterol intake<br>· Social network link to trade recipes, tricks, meal plans, and stories about their successes and failures.<br>· **S**yncs with external activity trackers and smart scales like the Withings Smart Scale and Fitbit<br>**App: CRON-O-Meter** (Cronometer Incorporated, 2016)<br>· Simple display<br>· Breaks down food into nutritional components<br>· Track calorie intake versus your personal goals<br>· Custom recipes and personal foods<br>· Tracks activity and exercise<br>· Cost $0 |
| Eczema | · Patient can track exacerbations:<br>- Severity of skin 1-10, at the time of exacerbation?<br>- Environmental factors?<br>- Activities at time?<br>- What symptoms was patient having?<br>- What area of body was affected?<br>- Have patient take a picture of skin with app | · What medications did the patient use?<br>· How were the patient's ADLs affected? | **App: The Eczema App** (Bayer HealthCare Pharmaceuticals Incorporated, 2014)<br>· Enables patients to record and track flare-ups over time, store photos of affected areas, and keep notes on their flare-ups and treatment.<br>· Provides news from the National Eczema Association and access to comprehensive information about the condition, which is categorized by age, including infant (3 months–2 years); toddler (2–4 years); kid (4–12 years); teen (13–18 years) and adult (> 18 years)<br>· Cost $0 |
| Fitness | · Patient can track:<br>- Food Calories/Input<br>- Exercise Calories/Output | Help patients see how lifestyle is affecting weight. | **App: My Fitness Pal** (2016)<br>· Tracks food<br>· Tracks exercise/output calories<br>· Connects to social media<br>· Cost $0 |
| Health/Medication History | · Keep diary of:<br>- Medications<br>- Allergies | · These are great for a patient in an emergency on vacation, etc. | **App: Mango Health** (2016)<br>· Includes medication dose reminders, drug interaction info, a health history |

| | | | |
|---|---|---|---|
| | - Immunizations<br>- Family health history<br>- Surgeries, etc. | | **App: Care Zone** (2016)<br>· Keeps track of medications, dosages, and schedules directly from patient's photo library<br>· Document symptoms<br>· **S**tore insurance information<br>· Schedule reminders for appointments.<br>· Personalized health tips<br>· Ability to assign to-do lists<br>· Store important documents for future reference<br>· Cost $0 |
| Hypertension | · Log:<br>- Blood pressure<br>- Food<br>- Activities<br>- Medications, etc. | · What treatments did patient used?<br>· Outcome of BP with or without treatment?<br>· Are there any patterns? | **App: SmartBP (**Evolve Medical Systems, LLC, 2016)<br>· Input BP measurements, weight, pulse so · Ability to track those over time.<br>· Display these readings in 3 different graphs (BP, weight, and pulse)<br>· Select from a number of time periods to see graph results (e.g., 1 week, 1 month, 1 year, etc.).<br>· Stores patient profile page for some basic patient data, including name, date of birth, gender, weight, height, and BMI<br>· Cost $0 |
| Insomnia/Sleep issues | · Record sleep<br>· Keep diary<br>· Keep diary of daily activity | · What noises were on recording?<br>- Snoring<br>- Grinding of teeth<br>- Talking<br>What medications were used?<br>· How were ADLs affected?<br>How did it affect mood? | **App: <u>Sleepbot</u>** (2016)<br>· Tracks patient's sleep patterns<br>· Tracks movement overnight, snoring, talking, and breathing problems and auto-records<br>· Tips to help improve sleep hygiene and fall asleep faster<br>· Widget to "clock in" and "clock out" when going to bed<br>· Alarm clocks<br>· Cost $0 |
| Pain - Chronic | Keep diary of:<br>- Pain type<br>- Pain severity 1-10<br>- Symptoms<br>- Non-pharm treatment | · What medications did the patient use?<br>· How were the patient's ADLs affected? | **App: Catch My Pain** (Sanovation AG, 2016)<br>· A pain-localization feature that allows patients to draw on an on-screen human figure with a finger, pinpointing which body parts hurt<br>· The tool uses color to denote intensity. |

| | | | |
|---|---|---|---|
| | | | · Ability to add more details about the pain, such as duration, intensity, and a verbal description<br>· Cost $0 |
| Renal Disease | · Keep diary of:<br>- Diet/intake<br>- Urination/outtake<br>- Pain<br>- Symptoms | · What medications did the patient use?<br>· How were the patient's ADLs affected? | **App: Pocket Dietitian** (2013)<br>· Ability to choose health condition and dietary restriction to align with recommended foods<br>· Keeps track of intake<br>· Displays past nutrition in graph<br>· Cost $0 |
| Rheumatoid Arthritis | Keep diary of:<br>- Pain type<br>- Pain severity 1-10<br>- Symptoms<br>- Non-pharm treatment<br>- Which joint had flares | · What medications did the patient use?<br>· How were the patient's ADLs affected? | **App: Rheumatrack** (GmbH, 2016)<br>· Allows patients to track pain, morning stiffness, infections, and other symptoms.<br>· Medication scheduler<br>· Appointment reminder<br>· Cost $0 |
| Skin | Keep photo diary of:<br>- Moles<br>- Skin growths<br>- Lesions<br>- Outbreaks<br>- Compare changes | · Any changes noted? | **App: UMSkinCheck** (The University of Michigan, 2012)<br>· Guidance on performing a skin cancer self-exam and full body photographic survey<br>· Tracking detected skin lesions and moles for changes over time<br>· Notifications/reminders to perform self-exams<br>· Storage of photos for baseline comparisons<br>· Informational videos and literature on skin cancer prevention<br>· Healthy skin as well as a skin cancer risk calculator function<br>· Cost $0 |

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**Unit 3: How to introduce mHealth applications to patients**

The introduction to mHealth apps should depend on the patient and the chronic illness. Preparatory instruction should take a sequential step by step approach:

Step 1: Determine the purpose of the mHealth app with respect to the patient's chronic illness.

- Patient Engagement
- Patient Self-Management
- More Data

Step 2: Verify that the patient:

- Owns a smartphone
- Is physically capable of using a mHealth app
    - Has sufficient manual dexterity of fingers and thumbs to input data
    - Has sufficient eyesight to read display on smartphone
- Is mentally capable of using a mHealth app
    - Has sufficient cognitive ability to navigate the graphical user interface
    - Has sufficient cognitive ability to follow simple instructions
    - Has sufficient cognitive ability to understand data needed for input
- Is emotionally capable of using a mHealth app
    - Understands not to input false data to get attention
    - Understands not to make treatment decisions without consulting a provider
    - Understands not to over react to data without consulting a provider

Step 3: Ask the patient if he/she would consider adding a mHealth app as a component to the treatment plan, and treat the mHealth app as an important component rather than an afterthought.

Step 4: Talk to the patient about the benefits and risks that a mHealth app could bring to their treatment plan.

**Table 2. Benefits and Drawbacks of mHealth App Usage**

| Patient Benefits | Potential Drawbacks |
|---|---|
| • Better health outcomes for patients<br>• Better data for treatment options<br>• More accurate medication titration<br>• Patient phones are usually close for data review | • Sending data via wireless or email could cause possible HIPAA violations for the providers<br>• Some apps cost money |

Step 5: Give the patient a list of clearinghouses and a list of apps to search for and download a mHealth app from a repository (iTunes Store or Google Play Store) from their smartphone. Show the patient how to search clearinghouses to find additional information on possible mHealth apps for their conditions. Counsel the patient that the evidence-based practice has shown that simpler mHealth apps tend to be more effective than complex ones. Instruct the patient to consider the cost, reviews and descriptions of the mHealth app before downloaded to their smartphone. Instruct the patient to try several mHealth apps to understand better the features that work well for them.

Step 6: Try out the app to ensure that it works as desired and has appropriate features. Since clinics often have multiple providers, it would be redundant to have each

provider research all available mHealth apps. mHealth research, selection, and trial runs can be done by multiple approaches:

- Create a committee to research mHealth apps
- Create teams to develop recommendations for mHealth apps
- Assign specific providers to select mHealth apps for specific chronic illnesses

Step 7: Instruct the patient on the limitations of mHealth apps. Due to possible HIPAA violations at the clinic, data transmission to the clinic's EHR system can be accomplished only by connecting the smartphone directly to the EHR computer with a physical wire, or by scanning printed hardcopies into the EHR.

Step 8: Create a plan for using the mHealth app with concrete goals for data input and reserve time to review data with the patient.

Step 9: Make sure that usage of the mHealth app is fun! Patients and providers should enjoy using the app to promote wellness.

**Unit 4: How to select mHealth applications**

*Repositories and Clearinghouses*

Providers and patients may select mHealth apps several ways, including through independent research and evaluation or through the assistance of mHealth clearinghouses. For independent research, publications such as Healthline (2016) provide reviews of mHealth apps. Web searches also hit many reviews of mHealth apps. Clearinghouses are on-line repositories that can aid in the selection of reviewed mHealth apps. Since these clearinghouses are dynamic in nature, providers should periodically search the clearinghouses and evaluate their contents. Many clearinghouses require free membership for access.

App stores are repositories, such as Google Play Store maintained by Google and iTunes Apps store maintained by Apple Computer. Apps on these repositories contain detailed descriptions including the number of downloads, the number of consumer reviews, the cost, and a description of the how the app works. End users will actually visit one of these stores to download the app directly to their smartphone. Before recommending a particular mHealth app, providers should consider the number of downloads, the rating by consumers and the description to see if the app will work well with the patient and the patient's chronic illness. Providers need to be familiar with the mHealth app, understand what specific data can be pulled, and understand the limitations of the mHealth app.

## Table 3: Clearinghouses for mHealth Apps (April 2016)

| mHealth App Clearinghouse | Description |
|---|---|
| AppScript (2016) | • Website: www.appscript.net/dashboard<br>• Access: Open to all, account creation required<br>• Description: Clearinghouse for mHealth apps and devices. Providers can write prescriptions for a specific app and have it emailed to a patient.<br>• Sponsor: IMS Health<br>• Supported Platforms: iPhone<br>• Cost: $0 |
| Eat Right (2016) | • Website: www.eatright.org/appreviews<br>• Access: Open to all, account creation encouraged<br>• Description: Contains apps for food, health, and fitness<br>• Sponsor: Academy of Nutrition and Dietetics<br>• Supported Platforms: iPhone<br>• Cost: $260 membership |
| FDA (U.S. Food and Drug Administration, 2015) | • Website: http://www.fda.gov/medicaldevices/digitalhealth/mobilemedicalapplications/default.htm<br>• Access: Open to all<br>• Description: Consumer guidance for mobile app usage. Listing of all mHealth apps under FDA regulation<br>• Sponsor: U.S. Food and Drug Administration<br>• Supported Platforms: iPhone, Android, Windows phone<br>• Cost: $0 |
| Happtique (n.d.) | • Website: www.happtique.com<br>• Access: **Temporarily down** due to security breach<br>• Description: Certification of mHealth apps<br>• Sponsor: Monkton Health<br>• Supported Platforms: iPhone, Android, Windows phone<br>• Cost: $0 |
| Health App Library (NHS, n.d.) | • Website: apps.nhs.uk<br>• Access: Open to all, account creation possible<br>• Description: Website includes a United Kingdom government funded clearinghouse<br>• Sponsor: National Health Services of the United Kingdom<br>• Supported Platforms: iPhone, Android, Windows phone<br>• Cost: $0 |
| iMedicalApps (2016) | • Website: www.imedicalapps.com<br>• Access: Open to all, account creation possible<br>• Description: An independent website that provides mHealth apps, research, and community reviews<br>• Sponsor: Independent company<br>• Supported Platforms: iPhone, Android, Windows phone<br>• Cost: $0 |
| University of Florida Diabetes Institute (2016) | • Website: diabetes.ufl.edu<br>• Access: Open to all<br>• Description: A clearinghouse for diabetes apps only<br>• Sponsor: The University of Florida<br>• Supported Platforms: iPhone, Android, Windows phone<br>• Cost: $0 |
| Zur Institute (2006) | • Website: www.zurinstitute.com/mentalhealthapps_resources.html<br>• Access: Open to all, account creation possible<br>• Description: Mental Health Website includes mHealth app clearinghouse for mental health professionals<br>• Sponsor: Zur Institute<br>• Supported Platforms: iPhone, Android, Windows phone<br>• Cost: $0 |

*Ratings and Reviews*

Providers and patients should carefully consider the ratings and reviews of all potential mHealth apps. Ratings are usually given on a scale of zero to five, with five being the highest. Before taking the face value of the rating, providers should consider the number of consumers that contributed to the score. For example, a total score of five for an app that has a single rating is not as reliable as a total score of four for a mHealth app with 100 ratings. A social network called Sermo (2016) specific to healthcare providers can be used to ask for advice and opinions on specific mHealth apps.

*The mHealth App Display*

The following items should be asked when selecting a mHealth app:

- Is the mHealth app inherently simple and easy to use?
- Does the mHealth app use common words around a $6^{th}$ grade reading level and explains medical terminology?
- Does the mHealth app transmit data or retain data locally?
- Does the mHealth app have password protection in case the smartphone is stolen?
- Does the mHealth app include reminders, or does it simply track data inputted by the patient?
- Does the mHealth app have an accurate educational component to it?
- Does the mHealth app have adaptive technology that adjusts reminders and recommendations based on past input, or non-adaptive technology that executes to programmed algorithms?
- Does the mHealth app display numerical data, graphical data, or both?

- Is data input amenable to patients with limited manual dexterity?
- Can data be input verbally or only by keyboard input?
- Can incorrectly inputted data be deleted?
- Does the patient like the appearance of the graphical user interface?
- Is the display at brightest for the elderly? (NHS, 2008)

*Exemplar mHealth App*

**SmartBP** (Smart Blood Pressure Tracker) Android and iPhone (Evolve Medical Systems, LLC, 2016)

As an example, SmartBP by Evolve Medical System is a mHealth app for the tracking of blood pressure for patients with hypertension, compatible with both Android and iPhone devices. This mHealth app makes data entry and displaying of BP easy for all users. The graphical user interface is easy to navigate with touch button on the homepage. Issues a patient may have with SmartBP include the "history" button being very close to the "share" button and both buttons were small. This could be difficult for patients with large fingers or dexterity problems. Also numbers such as weight and birthday were entered with a scroll bar; this would be hard to navigate for those with limited vison, inadequate dexterity and large fingers. The "history" display was complex and not visually appealing. The following table gives a brief summary of some critical data pulled from the previously mentioned clearinghouses regarding the mHealth app, SmartBP.


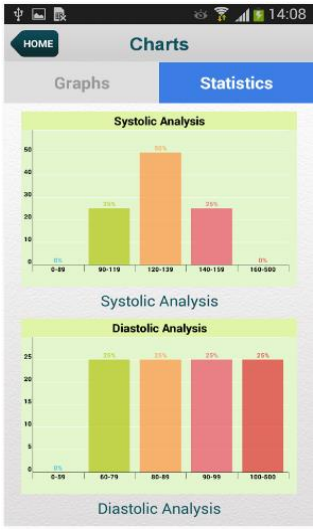

**Table 4. SmartBP Reviews**

| Reviews from the Repository/Clearinghouse | Score | Reviewer Likes | Reviewer Dislikes |
|---|---|---|---|
| AppScript | No data | No data | No data |
| Google Play Store | 3.8/5 | English, Spanish, Portuguese, Easy to understand | Scrolling dial awkward |
| Health App Library | No data | No data | No data |
| Health Line | 4.5/5 | Graphics and reports clear | None listed |
| iMedicalApps | 4.0/5 | Simple design<br>Good graphics | Lack of embedded reminders<br>No medication tracking |
| iTunes Store | 4.5/5 | Good design<br>Easy navigation | Numerous advertisements<br>Upgrading problematic |

*Trial Run*

Before asking patients to download a mHealth app, there should be a trial run. During the trial run, providers can determine if the mHealth app provides the appropriate data and is compatible with the skillset of the patients. Reviewing mHealth apps in each of these repositories took 10 to 15 minutes. The task for a trial run can be approached using different methods such as:

- Create a committee to research mHealth apps
- Create teams to develop recommendations for mHealth apps
- Assign specific providers to select mHealth apps for specific chronic illnesses

**Unit 5: What to include and not include in mHealth applications**

mHealth apps should be able to store and to display data relevant to the chronic illness of the patient. The selection of the mHealth app should depend on the nature and severity of the patient's chronic illness. A primary goal of mHealth app usage is better patient engagement and adherence. To this end, the ideal mHealth app should be one that the patient likes. According to Cocosila and Archer (2005), Cho et al. (2014), National Health Services Institute for Innovation and Improvement (2008), and Schmidt (2012) research shows that minimalist programs are more effective than complex ones. The display should be pleasing to the patient, and the ease or complexity of the program should agree with the desires and skillsets of the patients.

An important consideration is whether the mHealth app transmits data to a remote server or not. Data transmitted to the clinic's EHR system must be private under HIPAA laws. Providers should carefully weigh the need for transmitting data before using and allowing a mHealth app to transmit data to their EHR system. This best practice guide recommends against wireless transmission of data to the clinic's EHR system.

**Unit 6: Health and Legal Issues with mHealth applications**

Protecting patient privacy and data is important. The medical community works with the Health Insurance Portability and Accountability Act (HIPAA) to ensure that patient data remains private. mHealth apps are currently not regulated but they still need to adhere to laws such as those imposed by HIPAA when they are dealing with the healthcare clinic. The mHealth apps for this capstone project do not upload data to a server for retrieval but rather store data locally or on the individual's Cloud storage account. Many smartphones are frequently set up with Cloud data storage, a concept that is still poorly understood by many people at this time. Cloud storage means that data inputted into smartphones is automatically stored somewhere in the vast storage capability of the internet.

Many people are also naïve in their use of password protection, and smartphones with inadequate password protection could be stolen and mined for data. HealthIT.gov (2013) makes the following recommendations before downloading mHealth apps; 1. Research mHealth applications (apps) before downloading; 2. Download at home on a secure Wi-Fi network; 3. Use a password on smartphones; 4. Do not install or use file-sharing applications; 5, Maintain physical control; 6. Delete all stored health information before discarding or reusing the smartphones; 7. Keep your security software up to date. "Before you download and install an app on your smartphones, verify that it will perform only functions you approve of" (HealthIT.gov, 2013, expression 1).

Patients represent a wide range of skill sets and educational levels. For many patients, intuitive use of mHealth apps will suffice for data privacy and protection. For some patients, clear instruction is necessary for patient protection. In some cases,

patients may not be able to grasp the inherent complexities and may not be appropriate patients for mHealth apps. mHealth apps may also need to be controlled by a regulatory agency to prevent third party application vendors from creating mHealth apps that do not adhere to HIPAA regulations. It is critical, therefore, that patients understand the risks posed in this Information Age and use technology wisely.

*Best Practice Guide Recommendation for HIPAA*

Patients should keep all data on the mHealth app and not wirelessly transmit the data to the providers to minimize the threat of HIPAA violations. Providers may view patient data in several recommended ways:

- Patients can bring their smartphones to the provider who could view the results directly on the smartphone screen.
- Patients may also print hardcopies from home to bring to the clinic. The provider may view the hardcopy or scan the data into charts.
- Providers can download the data on the smartphones by making direct wire connections to secure computers at the clinic.
- Patients may capture a screenshot of data and email it to providers, but should be aware that email may be vulnerable to hackers. HIPAA violations can occur.

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