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Efficacy of a Mobile Application in a Chronic Kidney Disease Population

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EFFICACY OF A MOBILE APPLICATION IN A CHRONIC KIDNEY DISEASE POPULATION

by

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DEDICATION

This EBP project is dedicated to my children, Renee, Evan, Sarah, Alejandra, and Isabella. You are my inspiration for everything. I love you more than you'll ever know.

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ABSTRACT

Chronic kidney disease (CKD) is associated with high healthcare costs, poor health outcomes and low quality of life (Donald et al., 2018). The US CKD prevalence is 15%, costing Medicare $79 billion in 2016 (United States Renal Data System, 2018). Self-management could reduce CKD burden (Jeddi, Nabovati, and Amirazodi, 2017). Mobile technology offers a low-cost, ease-of-access platform for chronic disease self-management (Whitehead & Seaton, 2016), potentially slowing disease progression and improving health outcomes (Jeddi, 2017). The purpose of this project was to utilize a CKD-specific mobile application, CARELogiQ, to facilitate symptom management; increasing patient satisfaction and decreasing hospitalizations and ER visits over three months. A five-database literature review yielded six high-quality articles; three level I, two level II, and one level III evidence based on JHNEBP (Dang & Dearholt, 2017). Evidence supports a multifaceted approach to effectively use a CKD-specific mobile application for patient and provider communications, appointment and biometric check reminders, education, and telemonitoring of BP and weight. The Stetler Model guided the project (Stetler, 2001). In a Northwest Indiana nephrology clinic, CARELogiQ was used to report symptoms, communicate with patients and providers, and record medical appointments. DaVita's Kidney Smart© educational class provided education. Participants recorded weekly BP and weights manually in a log. Weekly calls collected BP and weight results, reminded participants to use CARELogiQ to report symptoms, encouraged medication adherence, and continued telemonitoring. Aggregate and person-to-person hospitalization/ER visit comparisons, and a post-intervention satisfaction-of-care survey were completed. Healthcare utilization was less in the intervention group (N = 10, M = 0.00, SD = 0.00) compared to the non-intervention group (N = 32, M = 0.125, SD = 0.42) ($t(40) = .930$, $p = .36$) . Rate of healthcare utilization in the intervention group (N = 10) did not change from pre (M = 0.00, SD = 0.00) to post-intervention (M = 0.00, SD = 0.00). Participants were satisfied with use of CARELogiQ. CARELogiQ has the potential to reduce healthcare utilization by improving self-management, thus effectively

impacting CKD burden. Significant outcomes may be attainable for future CARELogiQ projects by increasing sample size, lengthening implementation time, increasing functionality of CARELogiQ, and providing a smart device to participants.

CHAPTER 1

INTRODUCTION

Background

Chronic kidney disease (CKD) is defined by the Kidney Disease Improving Global Outcomes (KDIGO) as any consequential kidney structure or function abnormalities persisting greater than three months (2012). Hypertension (HTN) and diabetes mellitus (DM) are the most common causes of CKD (NKF, 2017). Based on the National Kidney Foundation's (NKF) Kidney Disease Outcomes Quality Initiative (KDOQI) 2002 guidelines, moderate CKD or Stage 3 CKD is described by a glomerular filtration rate (GFR) of 30 to 59 mL/min/1.73 m2, and severe CKD, Stage 4, is a GFR of 15-29 mL/min/1.73 m2 (KDOQI, 2002). The 2012 KDIGO guidelines further subcategorize the stages of CKD with albuminuria categories a1, a2, and a3 (KDIGO, 2012). While many patients do not experience symptoms until irreversible kidney damage has occurred, patients with CKD may experience nausea and vomiting, lack of appetite, fatigue and weakness, difficulty sleeping and mental impairments, muscle cramps, lower extremity swelling, itching, chest pain and shortness of breath, and changes in urination (Mayo Foundation for Medical Education and Research, 2018).

In the United States (US), the prevalence of CKD Stages 1-5 is 15%, with CKD Stages 3-5 at 7%, costing Medicare $79 billion for all CKD beneficiaries in 2016 (United States Renal Data System (USRDS, 2018). These numbers do not take into account the costs of CKD progressing into dialysis or kidney transplant. CKD is associated with high healthcare costs, as well as adversely affecting health outcomes and quality of life (Donald et al., 2018). Control of HTN and DM, along with correction of metabolic acidosis are part of the interventions identified to reduce progression of the disease (Vassalotti, Centor, Turner, Greer, Choi, Sequist, & NKF KDOQI, 2015). Symptom management would decrease hospitalization and emergency room (ER) visits, thus decreasing utilization of healthcare (He et al., 2017).

Data from the Literature Supporting Need for the Project

Vassalotti et al. (2015) encouraged the majority of CKD patients to be cared for by primary care clinicians, due to the prevalence of CKD exceeding the availability of nephrologists. Other literature suggests that self-management of CKD could also decrease the burden of this patient population on the healthcare system (Jeddi, Nabovati, & Amirazodi, 2017). According to Whitehead and Seaton (2016), chronic disease health outcomes may improve with self-management programs. The Institute of Medicine defines self-management as the individual's responsibilities to live well with one or more chronic diseases, which is commonly used in the literature pertaining to self-management topics (Packer, Francini, Audulv, Alizadeh, van Gaal, Warner, & Kephart, 2018). Lee, Wu, Hsieh, and Tsai (2016) further echo this definition of self-management, adding that self-management encompasses self-monitoring and symptom management.

Mobile technology (mHealth) may offer a low cost, ease of access platform to implement self-management interventions of chronic conditions (Whitehead & Seaton, 2016). In recent years, healthcare has seen a boom of mobile phone applications (app) utilized not only for chronic disease management, but specifically CKD as well, including self-management (Jeddi et al., 2017). Utilizing an app to self-manage CKD along with symptom monitoring has the potential to slow disease progression and improve health outcomes (Jeddi et al., 2017). While poor self-management and lack of adherence to treatment guidelines can lead to adverse clinical outcomes, this type of app can facilitate the patient's self-management by easing the acquisition of health information and improving communication with HCPs, as well as encouraging compliance with blood sugar and blood pressure (BP) monitoring, supporting physical activity, providing nutritional guidelines, and promoting adherence to medication regimens (Jeddi et al., 2017).

Data from the Clinical Agency Supporting Need for the Project

A local nephrologist has developed an app to facilitate CKD self-management in his patient population. The app has the ability to record and, if necessary, access the patient's health care provider (HCP) to report symptoms, as well as deliver personalized education to the patient. The nephrologist was interested in utilizing the app for symptom management with a goal to increase patient satisfaction of their care with the use of the app, while decreasing healthcare utilization, including hospitalizations and ER visits. Out of 264 active patients, the practice had 180 patients with stage III to stage V CKD.

Purpose of the Evidence-Based Practice Project

The purpose of this project was to evaluate the effectiveness of a mobile application developed by a local nephrologist to facilitate symptom management in order to increase patient satisfaction and to decrease hospitalizations and emergency room visits over a four-month period.

PICOT Question

Among patients with moderate to severe CKD (P), how effective is the mobile application, CARELogiQ, to self-manage symptoms (I) compared to non-intervention (C) in order to reduce healthcare utilization and increase patient satisfaction with care (O) over a four-month period (T).

Significance of the EBP Project

Implications of this project were to initiate the use of an app developed by a local nephrologist in an outpatient CKD clinic to positively affect CKD self-management resulting in increased patient satisfaction of care and decreased hospitalizations and ER visits. Self-management in this CKD population has the potential to improve healthcare outcomes, as well as decrease costs associated with hospitalization and ER visits.

CHAPTER 2

EBP MODEL AND REVIEW OF LITERATURE

In this chapter, the process of this EBP project will be expanded upon with the guidance of the Stetler model of evidenced-based practice. “Johns Hopkins Nursing Evidence-Based Practice Research Evidence Appraisal Tool” (JHNEBP) is utilized to appraise the level and quality of evidence used to develop best practice recommendations in order to guide the practice change.

Evidence-based Practice Model

Overview of EBP Model

The Stetler model of evidenced-based practice is a step-by-step approach to use research evidence in developing nursing practice (Stetler, 2001). Research can be used instrumentally, conceptually, or symbolically, in an informal or formal way, directly or indirectly, at the level of the individual, group, or organization (Schmidt & Brown, 2019). According to Stetler (2001), the use of knowledge is influenced not only by a user’s internal characteristics, but also by external environmental factors. This model consists of five phases: Preparation, Validation, Comparative Evaluation/Decision Making, Translation/Application, and Evaluation (Stetler, 2001). The model was selected to guide this project due to the applicability to an individual practitioner with an increased level of knowledge and skill, which facilitated decision making to translate research findings into practice (Stetler, 2001). This model guided the process of participants using a mobile application to self-manage symptoms associated with CKD.

Application of EBP Model to DNP Project

Phase I: Preparation. The first step in the Stetler model is identifying the problem. The problem for this EBP project is CKD being associated with high healthcare costs, as well as adversely affecting health outcomes and quality of life (Donald et al., 2018). The catalyst for this

specific project was an innovative program goal. A local nephrologist developed a mobile app and requested a project leader to guide operationalizing this intervention. The interest of the nephrologist in launching a newly developed app is an influencing factor. The project leader seeks to know if employment of a mobile application to manage symptoms decreases unscheduled healthcare utilization. The literature was reviewed based on a clinical question and a PICOT question was developed. A search strategy was prepared as shown in Table 2.1. The highest levels of evidence were sought to guide this project.

Phase II: Validation. The second step in the Stetler model is validation (Stetler, 2001). The literature was searched for relevant articles pertaining to the use of a mobile app to promote self-management of chronic diseases, including CKD. The selected articles were evaluated and appraised with the JHNEBP tool for level and quality. An evidence table was created, as shown in Table 2.2, including the level and quality of each piece of evidence. The project leader decided to continue the EBP process due to the selected evidence determined to be fit for use.

Phase III: Comparative evaluation/Decision Making. In the comparative evaluation and decision-making phase, synthesis of the evidence and evaluation of commonalities to be used in project was completed, leading to best practice recommendations. The project leader decided to use these findings to change practice by using the CARELogiQ app to aid participants in self-management of CKD.

Phase IV: Translation/Application. A plan of change to implement the CARELogiQ app was formulated and was acted upon. Participants downloaded the mobile app and utilized the platform as previously described.

Phase V: Evaluation. In this phase, the project leader evaluated the outcome data to determine if the practice change of implementing the CARELogiQ app to facilitate symptom management met the outcome goals of increasing patient satisfaction and reducing healthcare utilization over a four-month period. Formal evaluation (formative and summative) of the

implementation of a mobile app to manage symptoms to decrease unscheduled healthcare utilization was conducted in this stage.

Strengths and Limitations of EBP Model for DNP Project

Strengths of the Stetler model include the ability to integrate research into practice either informally or formally, at an individual level or up to an organizational level, incorporating evidence into daily practice. Since the project leader was working mostly on her own, this model worked to guide the EBP project. The model also accommodated for collaboration with staff during retrieval of patient information.

A limitation of the Stetler model is the need for a project leader to be competent, having sufficient knowledge and skill of EBP practice to successfully use this EBP model.

Literature Search

Sources Examined for Relevant Evidence

An exhaustive search of the following databases was completed (see Table 2.1): Cumulative Index of Nursing and Allied Health Literature (CINAHL), Cochrane Library, Johana Briggs Institute (JBI), Medline with full text via EBSCO (Medline), ProQuest Nursing and Allied Health Literature (ProQuest). Keywords searched within CINAHL, Medline, and ProQuest with Boolean operators were (“chronic kidney disease*” OR “chronic disease*”) AND (mHealth OR m-health OR “mobile app*” OR “mobile health” OR smartphone* OR “cell* phone*”) AND (“self manag*” OR “self care”). Cochrane Library was searched with the MeSH heading (MM mobile applications). JBI was searched with (chronic kidney disease OR chronic disease AND mHealth OR m-health OR mobile application OR mobile health OR smartphone OR cellphone) with a five-year limiter. While CKD was the focus of this EBP project, due to the limited results specific to CKD, the search was expanded to chronic diseases as well. A Prisma flow diagram (see Figure 2.1) details the search process.

Table 2.1

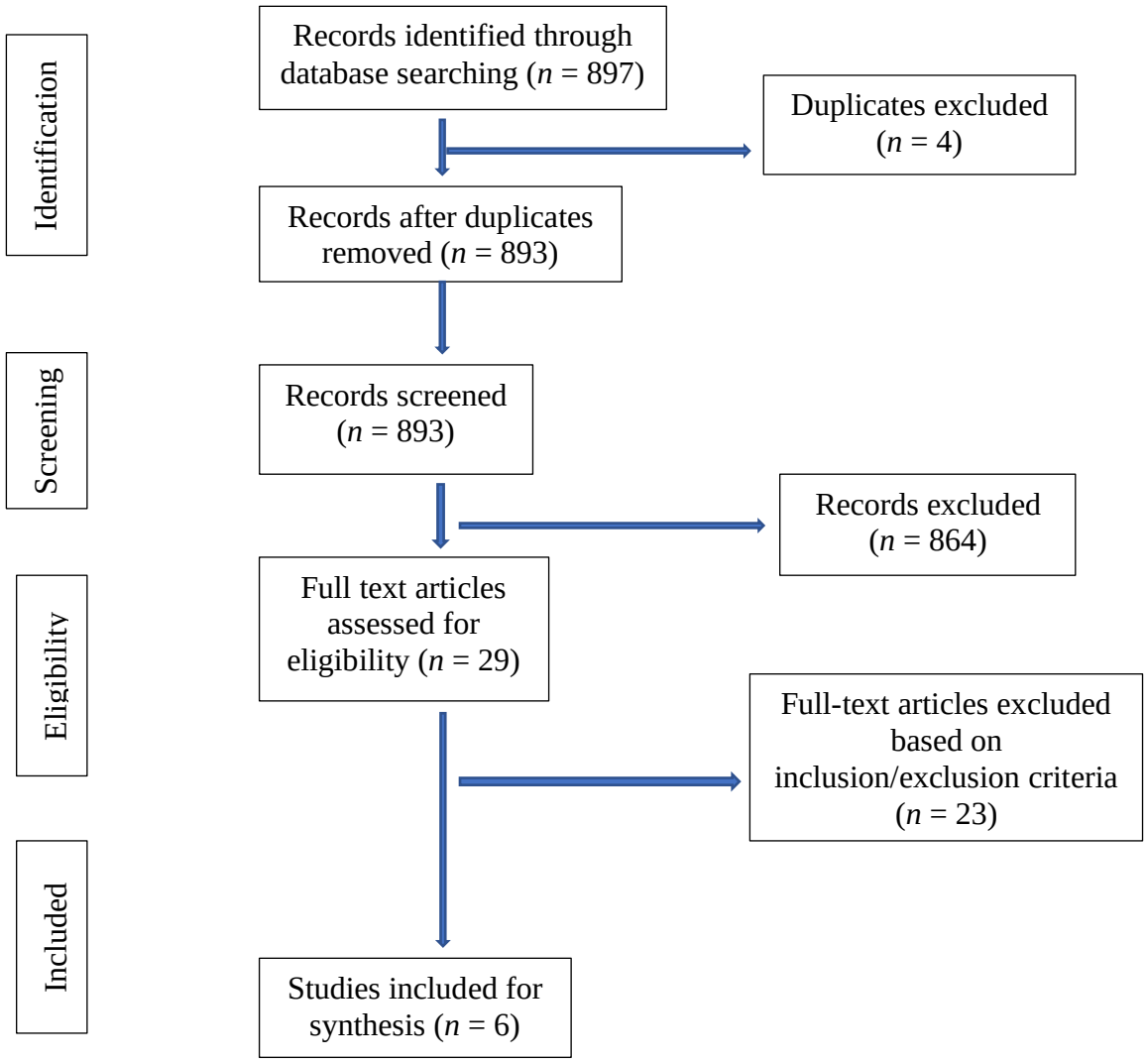
Literature Search Results

Database	Keyword(s)	Limiters	Date Restraints	Results	Relevance/Saved
CINHAL	(“chronic kidney disease*” OR “chronic disease*”) AND (mHealth OR m-health OR “mobile app*” OR “mobile health” OR smartphone* OR “cell* phone*”) AND (“self manag*” OR “self care”)	English Peer Reviewed	June 2014-June 2019	74	2 Systematic Reviews
Cochrane Library	(MM mobile applications)	English Peer Reviewed	June 2014-June 2019	4	0
Johana Briggs Institute	(“chronic kidney disease*” OR “chronic disease*”) AND (mHealth OR m-health OR “mobile app*” OR “mobile health”)	English Peer Reviewed	June 2014-June 2019	25	0
Medline with Full text via EBSCO	(“chronic kidney disease*” OR “chronic disease*”) AND (mHealth OR m-health OR “mobile app*” OR “mobile health” OR smartphone* OR “cell* phone*”) AND (“self manag*” OR “self care”)	English Peer Reviewed	June 2014-June 2019	252	3 (2 Systematic Reviews, 1 Overview of Systematic Reviews, 2 duplicates from CINAHL)
ProQuest Nursing and		English	June 2014-June 2019	541	0 (2 duplicates in Medline)

Allied Health Database Hand Search (JMIR 2018)	(“chronic kidney disease*” OR “chronic disease*”) AND (mHealth OR m-health OR “mobile app*” OR “mobile health” OR smartphone* OR “cell* phone*”) AND (“self manag*” OR “self care”)	Peer Reviewed English Peer Reviewed	June 2014-June 2019		1 Systematic Review of Systematic Reviews

Figure 2.1

Prisma Flow Diagram



Levels of Evidence

Level of evidence for this EBP project was assessed by using the JHNEBP, which categorizes evidence based on the level of study design (Dang & Dearholt, 2017). Dang and Dearholt (2017) presume that the higher the level and quality of the evidence, the stronger the recommendation represents best practice. Answering three simple questions determines the level of evidence, ranging from I to III (Dang & Dearholt, 2017).

Level I evidence incorporates the following study types: experimental studies, randomized controlled trials (RCTs), explanatory mixed methods with only level I quantitative studies, or systematic reviews of RCTs, with or without meta-analysis (Dang & Dearholt, 2017). Dang and Dearholt (2017) categorize level II evidence as quasi-experimental studies, explanatory mixed methods with only level II quantitative studies, or systematic reviews consisting of RCTs and/or quasi-experimental studies, with or without meta-analysis. Level III evidence is comprised of quantitative nonexperimental studies; explanatory mixed methods with only level III quantitative studies; exploratory, convergent, or multiphasic mixed methods studies; systematic reviews of a combination of RCTs, quasi-experimental, and/or nonexperimental studies; or qualitative studies or systematic reviews of qualitative studies, with or without meta-analysis (Dang & Dearholt, 2017).

The evidence used in this EBP project were all systematic reviews ranging from level I (three pieces of evidence utilizing all RCTs) to level II (three pieces of evidence utilizing a combination of RCTs and non-RCTs) (see Table 2.2).

Appraisal of Relevant Evidence

JHNEBP also facilitates appraisal of quality of evidence by utilizing a straightforward 12-item checklist to appraise the quality of systematic reviews, ranging from High to Low (Dang & Dearholt, 2017). High quality evidence is consistent with generalizable results; sufficient sample sizes for study design; and provides adequate control, definite conclusions, and consistent recommendations which is based on a comprehensive, scientific literature review (Dang &

Dearholt, 2017). Good quality differs from high quality in that results are reasonably consistent, with some control; conclusions are fairly definitive; and recommendations are reasonably consistent, based on fairly comprehensive literature that includes some scientific evidence (Dang & Dearholt, 2017). Grades of Low quality or Major flaw encompass little evidence with inconsistent results, insufficient sample size for the study design, and inability to draw conclusions (Dang & Dearholt, 2017). All six of the systematic reviews used in this EBP project were of high quality, based on JHNEBP, although many of the studies used in the reviews were of moderate to low quality, due to small sample sizes.

Level I evidence. Jeddi et al. (2017) produced a systematic review of eight RCTs evaluating the efficacy of IT-based interventions on self-management clinical outcomes (BP, interdialytic weight gain, intact parathyroid hormone, and ultrafiltration rate) and process of care outcomes (medication adherence, patient knowledge, medication dose/usage, BP, and sodium intake) in CKD patients. The interventional classifications consisted of use of smartphone/personal digital assistant devices (PDAs) (software/application/short message service (SMS)) to transfer data to HCP/researchers, use of wearable devices to record BP and weight, computerized systems for data transfer to and from patients through the internet, or a combination of all three. The duration of the studies lasted from three weeks to 12 months. The smartphone/PDA functionalities were categorized by inform, record, display, communicate, remind/alert, and guide. The results showed statistically significant outcomes in 80% of the studies, with 75% being clinical outcomes and 86% process of care outcomes. Quality was assessed as high, based on the results (consistent, generalizable), sample size (sufficient), control (adequate), conclusions (definite), and recommendations (consistent/based on scientific evidence).

Lee, Choi, Lee, and Jiang (2018) completed a systematic review of 12 RCTs to examine the effectiveness of mHealth interventions on chronic disease management health outcomes and process measures. MHealth interventions utilized smartphones as a mobile device, tablets,

or telemonitoring wireless devices with components of remote symptom monitoring/self-assessment, automatic messages, and education. Duration of studies ranged from two to 12 months. Health outcomes were measurements of physical functioning (gait/balance, fatigue, etc.), psychological functioning (quality of life, depression, and anxiety), medication adherence, and/or ease of symptom evaluation and reporting to HCPs. Process measures included patient satisfaction and interventional feasibility. Incorporating mobile applications in chronic disease management showed a statistically significant effect on outcomes of interest in 83.3% of the studies. The authors concluded that automated text reminders, frequent and accurate symptom monitoring, and improved communication between patients and HCPs result in improved chronic condition self-management. Quality was assessed as high, based on the results (consistent, generalizable), sample size (sufficient), control (adequate), conclusions (definite), and recommendations (consistent/based on scientific evidence).

Whitehead and Seaton (2016) conducted a systematic review of nine RCTs assessing the efficacy of symptom self-management utilizing mobile phone and tablet apps on disease specific outcomes, which included blood glucose (BG), asthma symptoms, medication use, peak flows, BP, weight, and pedometer counts. Interventions included the use of a disease specific app with or without automatic feedback, either alone or in combination with clinician input or support (either by text or phone call). Chronic diseases of patients in this study included DM, chronic lung disease, and cardiovascular disease (CVD). The duration or ranged from three months to one year. Statistically significant effects were shown in 66.6% of studies on disease specific outcomes and some combination of app usage. App only interventions were statistically significant in improvement of symptom management in 60% of the studies. Quality was assessed as high, based on the results (consistent, generalizable), sample size (sufficient), control (adequate), conclusions (definite), and recommendations (consistent/based on scientific evidence).

Level II evidence. A systematic review of systematic reviews by Kitsiou, Pare, Jaana, and Gerber (2017) evaluated the efficacy of mHealth interventions of remote patient monitoring and clinical feedback delivery for DM self-management (encouragement, education, reminders, and recommendations) on glycemic control in diabetic patients. This review examined 15 systematic reviews, seven of which were comprised of RCTs only and the remaining were comprised of RCTs, non-RCTs, and cohort studies with pre-post design. MHealth interventions included SMS, mobile applications, Blue-tooth enabled glucometers, and data entry/patient support through cellphone accessible websites/web-portals. Duration of studies were from two weeks to 12 months, with most study durations being three to 12 months. The one measurable outcome was glycemic control defined by HgA1c. There was no effect found from text messaging alone. Nonstatistical positive effect was found with combination of SMS and internet app for transmission of BG, reinforcement of diet/exercise, education and medication adjustment. Text messaging combined with clinical feedback had a statically significant effect on glycemic control. Addition of an education component increased the effect size. Quality was assessed as high, based on the results (consistent, generalizable), sample size (sufficient), control (adequate), conclusions (definite), and recommendations (consistent/based on scientific evidence).

A systematic review of 23 systematic reviews of RCTs and non-RCTs by Marcolino et al. (2018) evaluated the effects of mHealth interventions on chronic and noncommunicable diseases, such as asthma, cardiac disease, congestive heart failure, chronic lung disease, cancer, and DM. The most frequent interventions included SMS for reminders, education, motivation, or prevention. Duration of interventions lasted from a few minutes to 24 months. Primary outcomes were divided into clinical outcomes (frequency of hypoglycemic events, symptoms, or death), surrogate outcomes (HgA1c, BP, lipid profile, CVD risk profile, lung function, neb use, weight, BMI, behavioral or lifestyle changes), and process of care outcomes (attendance rates, medication compliance, data management, communication, time to dx, time

to treat, or professional workload changes). Secondary outcomes were cost, patient satisfaction, and potential harms and adverse effects. Regarding clinical outcomes, mHealth interventions improved symptoms in asthma (text messaging), chronic obstructive pulmonary disease (SMS program), and heart failure (mobile technology counseling).

There were no statistically significant improvements in chemotherapy symptoms (mobile app symptom report with recommended self-care advice) (Marcolino et al., 2018). MHealth interventions resulting in surrogate outcomes showed improved peak flow scores in asthma, reduced mortality and hospitalizations, improved QOL, improved glycemic control, and improved BP. SMS reminders improved process of care outcomes as evidenced by attendance rates, reduced costs, and improved adherence to TB and HIV therapy resulting in decrease viral load. Secondary outcomes were also improved by mHealth interventions, as evidenced by effective data collection and reporting, reduction of face to face communication, reduction in communication delays, improved patient-provider communication, and statistically significant provider to provider communication. Quality was assessed as high, based on the results (consistent, generalizable), sample size (sufficient), control (adequate), conclusions (definite), and recommendations (consistent/based on scientific evidence).

Level III evidence. Alessa, Abdi, Hawley, and de Witt (2018) completed a systematic review. The purpose of the study was to assess the efficacy of an app to lower BP in individuals with one or more of the following: HTN, metabolic syndrome risk factors, obstructive sleep apnea with high cardiovascular risk, and overweight, while also assessing the usability of the app and patient satisfaction with the use. This systematic review synthesized 21 (nine RCTs, 10 quasi experimental studies and two qualitative studies). While the inclusion of the two qualitative studies lowered the evidence level to III, those two articles specifically focused solely on the usability and user satisfaction component of the systematic review. This source of evidence was included due to the remaining 19 studies focused on the efficacy of the app related to BP to be of level II evidence (RCTs and quasi-experimental studies). The interventions in this review

were a mobile phone or tablet app that collected data, provided feedback, connected with/informed HCP in order to self-manage (measure BP/other biometrics, healthy diet, physical activity, weight management, medication adherence, and stress management/coping) to HTN. The app functions were categorized into seven main functions: self-monitor, goal setting, remind/alert, automatic feedback, education, HCP communication, and stress management. Duration of the studies ranged from one to 12 months. Study outcomes were BP measurements and mobile app usability, attitudes, and satisfaction. Alessa et al. (2018) concluded that 67% of the studies showed a significant association between app use and decreased BP, although evidence was inconclusive regarding which combination of functionality of the app was most effective. The app was highly acceptable and easy to use, and participants were satisfied with use of the app. Quality was assessed as high, based on the results (consistent, generalizable), sample size (sufficient), control (adequate), conclusions (definite), and recommendations (consistent/based on scientific evidence).

Table 2.2

Evidence Table

Citation (APA)	Purpose	Design	Sample	Measurement/ Outcomes	Results/ Findings	Level/ Quality
Alessa, T., Abdi, S., Hawley, M.S., de Witte, L. (2018).	To assess the effectiveness of using apps to lower blood pressure, and to assess usability and patients' satisfaction with app usage	Systematic review with RCTs and quasi experimental studies	21 studies (9 RCTs, 10 quasi experimental studies, and 2 qualitative studies *n* = 3112 with a mean age of 42.4 to 69.5 years having hypertension, metabolic syndrome risk factors, obstructive sleep apnea with high cardiovascular risk, and/or overweight	Effectiveness of apps in lowering blood pressure Effectiveness of apps in app usability Effectiveness of apps in patients' satisfaction of use	There was a significant association ($p < .05$) between use of apps and decreased blood pressure in 67% of the studies. The app was highly accepted in all 9 studies. Participants were satisfied with the apps, accepted using them and found them easy to use.	Level III Quality High

Jeddi, F.R., Nabovati, E., Amirazodi, S. (2017).	To assess the features and effects of automated IT-based interventions on the outcomes of self-management in CKD patients	Systematic review of RCTs	8 RCTs *n* = 1637 including Hispanic transplant candidates and their family and friends, hemodialysis patients, adults with CKD or diabetes, including veterans, with uncontrolled blood pressure	Effectiveness of the IT intervention on clinical outcomes (BP, IDWGA, iPTH and ultrafiltration rate) Effectiveness of the IT intervention on process of care outcomes (medication adherence, patients' knowledge, medication dose, medication usage, BP reading, and dietary sodium intake)	Self-management outcomes statistically significant (p < .0001 to .05) in 80% of the studies (75% of the clinical outcomes and 86% of the process of care outcomes).	Level I Quality High

Kitsiou S., Pare, G., Jaana, M., & Gerber, B. (2017).	To systematically pool evidence on the effectiveness of mHealth interventions in patients with diabetes	Systematic review of systematic reviews containing RCTs, non-RCTs, and cohort studies	15 systematic reviews (7 RCTs only, 8 with RCTs, non-RCTs, and cohort studies with pre-post design) *n* = 11,833 patients with diabetes	Effectiveness of mHealth interventions (text messaging of encouragement, education, reminders, and recommendations, mobile apps, Blue-tooth enabled glucometers, websites/portals for data entry and patient reports) on HbA1c	No effect on HgA1c from text messaging alone [MD -0.15% (95% CI: -0.77, 0.47)]. Positive, insignificant effect [0.3% (CI: 0.0, -0.5%)] of combined SMS with Internet app for transmission of BG, reinforcement of diet and exercise, education, and medication adjustment. Text messaging and clinical feedback have a beneficial effect on glycemic control [MD of -0.05% (95% CI: -0.74, -0.26), 3 trials, 280 patients]. Addition of education component increased effect size (MD -0.85% vs -0.43).	Level II Quality High

Lee, J., Choi, M., Lee, S.A., & Jiang, N. (2018).	To examine the effectiveness of mHealth interventions on health outcomes and process measures of chronic diseases	Systematic review of RCTs	12 RCTs *n* = 3469 including adult patients with lung, breast, or colorectal cancer on chemotherapy; fibromyalgia; heart failure; allergic rhinitis and asthma; spina bifida; cardiovascular disease; Parkinson's disease; and lung transplants	Effectiveness of the mHealth interventions on health outcomes (physiological =gait/balance, fatigue, nausea/vomiting/diarrhea, sore mouth/throat, hand-foot syndrome, and pain) and (psychological = QOL, depressive symptoms, anxiety) and process measures (participants' adherence to, satisfaction with, and/or the level of engagement with mHealth systems)	Of the articles, 83.3% showed statistically significant effect (*p* = .001 to .05) on health outcomes by incorporating mobile apps in managing chronic dx (improved physical functioning, adherence to prescribed meds, and/or ease of symptom evaluation and reports to care providers), and process measures (patient satisfaction with mHealth management and ease of use of smartphone based self-management interventions).	Level I Quality High

Marcolino, M.S., Oliverira, J.A.Q., D'Agostino, M., Ribiero, A.L., Alkmim, M.B.M., & Novillo-Ortiz, D. (2018).	To assess the effectiveness of mHealth interventions on chronic and non-communicable disease	Systematic review of systematic reviews containing RCTs and non-RCTs	23 systematic reviews *n* = 79,665	Primary outcomes: -clinical (frequency of hypoglycemic events, symptoms, death) -surrogate (HgA1c, BP, lipid profile, CVD risk profile, lung function, neb use, weight, BMI, behavioral or lifestyle changes) -process of care (attendance rates, medication compliance, data management, communication, time to dx, time to treat, professional workload changes) Secondary outcomes: cost, patient satisfaction and potential harms and adverse effects	mHeath interventions improved symptoms in asthma (text messaging) [MD 0.36, (95% CI: -0.56, -0.17)], and HF (mobile technology counseling) (RR reduction 20%). No statistically significant improvement in COPD (SMS program) or chemotherapy symptoms (mobile app symptom report with recommended self-care advice). Improved peak flow scores in asthma [MD -11.12, CI: 95%, -19.56, -2.68)], reduced mortality and hospitalizations, improved QOL, glycemic control, and BP. SMS reminders improved attendance rates, reduced costs, and improved adherence to TB and HIV therapy resulting in decrease viral load. Effective data collection and reporting, reduction of face to face communication, reduction in communication delays, improved patient-provider communication, statistically significant provider to provider communication. *not all statistics given in article	Level II Quality High

Whitehead, L., & Seaton, P. (2016).	To assess the effectiveness of mobile phone and tablet apps in self-management of key symptoms of long-term conditions	Systematic review containing RCTs	9 RCTs *n* = 2278 patients aged 33.8 to 72.1 years with diabetes, chronic lung disease, and cardiovascular disease	Effectiveness of mobile phone and tablet app on disease specific outcomes (DM, chronic lung disease, and CVD)	Of the articles, 66.6% of interventions showed statistically significant effects on disease specific outcomes of interest. 60% app only interventions statistically significant in improvement of symptom management. *statistics of individual RCTs not given in article.	Level I Quality High

Construction of Evidence-based Practice

Synthesis of Critically Appraised Literature

Synthesis of the preceding literature identified mHealth interventions to improve outcomes in chronic disease, which may be translational to a CKD population due to similar needs of this chronic disease population. Common themes to improve disease-specific outcomes include communication, reminders, telemonitoring, and education (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, Marcolino et al., 2018, and Whitehead & Seaton, 2016). Use of these common themes can translate into best practice for implementation of a mobile app to manage symptoms in patients with CKD.

Communication. In all six appraised sources of evidence, mHealth utilized communication to improve measured outcomes (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, Marcolino et al., 2018, and Whitehead & Seaton, 2016). Communication between patient and HCP, as well as communication between HCPs is a valuable intervention. Communications in the reviewed literature were either sent to the patients by being generated by a HCP or were sent as a result of the app's automated responses (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, Marcolino et al., 2018, and Whitehead & Seaton, 2016).

Reminders. Another function that seems to be a commonality between four of the six sources of evidence is the use of reminders (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, and Marcolino et al., 2018). Reminders addressed appointment times as well as medication times and disease-specific biometric evaluations, such as BP checks.

Telemonitoring. Telemonitoring or the wearing of a device to record and/or transmit biometric readings, such as BP, weight, gait, BG, and peak flows, was also demonstrated to improve disease-specific outcomes in five of six articles (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, and Marcolino et al., 2018).

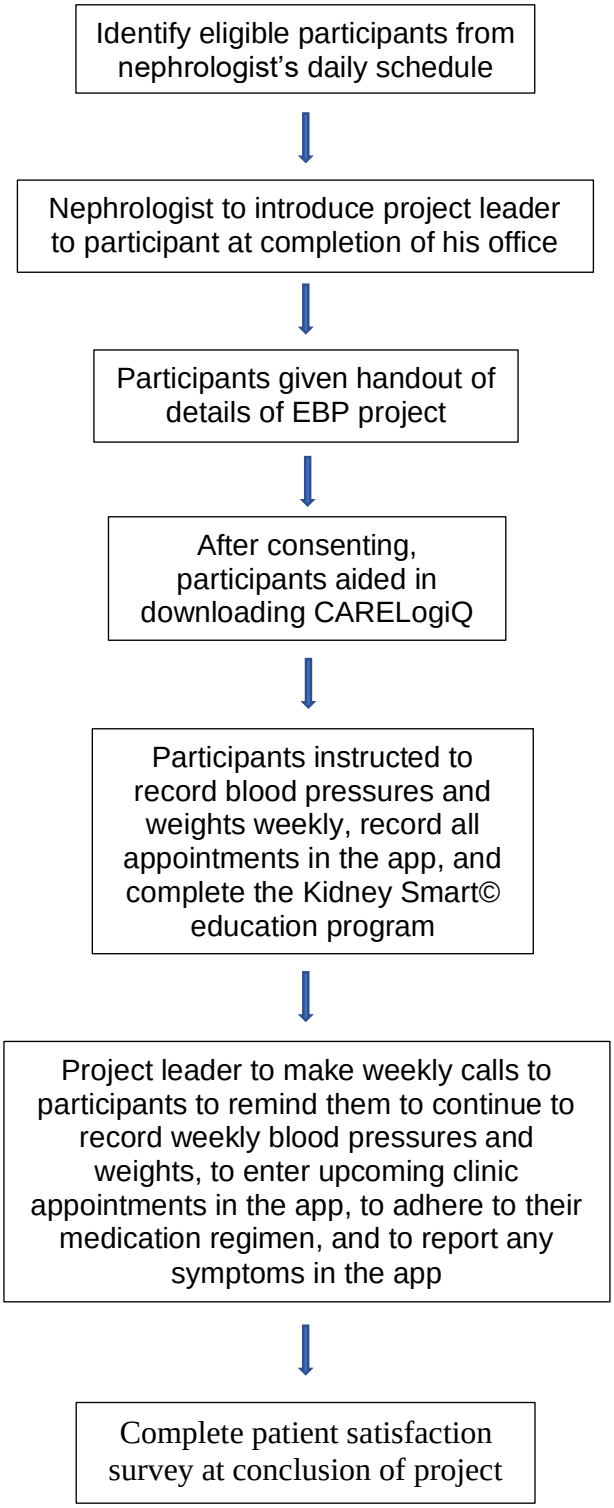
Education. Five of six articles demonstrated disease-specific education as an integral part of a mHealth intervention (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, and Marcolino et al., 2018). Media used for education included SMS, internet, email and videos.

Best Practice Model Recommendation

After reviewing the appraised literature, the identified best practice to address implementation of a mobile app to manage symptoms in patients with CKD incorporates communication, reminders, telemonitoring, and education (see Figure 2.2). By integrating these components into practice, reduced healthcare utilization and increased patient satisfaction was expected.

Figure 2.2

Practice Change



CHAPTER 3

IMPLEMENTATION OF PRACTICE CHANGE

The CARELogiQ platform was the cornerstone of this practice change. Eligible participants downloaded the CARELogiQ app to begin the process of self-management. Practice change was implemented by utilizing the synthesized best practice interventions explained above.

Participants and Setting

Participants taking part in this practice change were patients of a local nephrologist, with CKD, between stages III and V, not on dialysis. The project site was an outpatient nephrology practice in a Midwest town, consisting of nine nephrologists and seven office locations. Only patients of the nephrologist who developed the mobile application were included to participate. Only one of this nephrologist's two offices was the initial target site of the EBP project. Due to a low number of participants, a second office site was added.

Complete inclusion criteria for this EBP project required participants:

- 18 years or older
- English speaking
- CKD III to V (including post transplant)
- Consent to participate in the project
- Have a smartphone capable of installing this application
- Agree to download and use the application
- Able to navigate the application

Potential participants were excluded from participating in the project based on the following criteria:

- Currently receiving dialysis
- Pregnancy

Pre-Intervention Group Characteristics

The targeted nephrology practice was comprised of 264 adult patients, with 180 of these patients diagnosed with CKD III to IV. Of those 180 patients, 146 had stage III CKD, 27 had stage IV CKD, two had stage V CKD, and five were stage V post transplantation. Patients with CKD III made up 55.3% of the total population and 81.11% of the moderate to severe CKD population, while CKD IV was 10.22% and 15%, CKD V was 0.75% and 1.11%, and CKD V post transplantation was 1.89% and 2.77%. Eighty-five (47%) of the 180 patients were male, and 95 (53%) were female. Within this group, race/ethnicity for 37 (21%) were “not available”, three (2%) were “not available/not Hispanic”, 94 (52%) were “white/not Hispanic”, four (2%) were “white/Hispanic”, 36 (20%) were “black or African American (AA)/not Hispanic”, one (1%) was “black or AA/not available”, two (1%) were “Asian/not Hispanic”, and one (1%) was “other/not Hispanic”. Patients were considered to be part of the practice if they have been seen in the office within the past year.

This EBP project targeted as many participants as possible from the nephrology group who met the stated project inclusion criteria. Comparison data consisting of CKD stage, BP, weight, and hospitalizations and/or ER visits was collected from the previous year’s visits, as well as the current visit.

Intervention

To prepare for this EBP intervention, a plan was developed to provide step-by-step guidance for the project leader and the staff at the facility. First, eligible potential participants were identified from the nephrologist’s daily patient schedule. At the conclusion of the office visit, the nephrologist introduced the patients to the project leader. After an introduction of the EBP project, potential participants decided whether to join the project. Once participants consented to join the project, the project leader gave participants a handout of instructions on how to download and use the mobile application. Participants had the opportunity to download the mobile application with the project leader while in the office. Participants also were given

instructions on recording weekly home BP and weight measurements, as well as instructions for the educational resource, DaVita's Kidney Smart© educational website.

Initiation of the intervention began with participants recording weekly home BPs and weights. Weekly calls to participants were made by the project leader to remind the participants to continue home BP and weight recordings, to collect a weekly home BP and weight, to encourage entering upcoming clinic appointments into the mobile application, to encourage adherence to medications, and to promote the use of the mobile application to report symptoms as any arose. Participants with abnormal BPs or weights were encouraged to follow up with their treating provider. The duration of the intervention was planned for 12 weeks. Participants continued enrollment through October 2019. At the conclusion of intervention, participants were given a participant satisfaction survey to assess their satisfaction with utilizing the mobile application.

Comparison

Collection of pre-intervention data was necessary to serve as a comparison to post-intervention data in order to analyze the efficacy of the project. Once a participant was initiated into the project, the project leader reviewed that participant's chart for healthcare use, consisting of unscheduled hospitalizations or ER visits for the previous year, as well as for office visits other than scheduled follow-up appointments within the previous year. The project leader also reviewed the participant's chart in order to collect data of the BP readings, last weight, and the stage of CKD over the past one year of office visits.

Data collection of a non-intervention comparison group was completed. Thirty-two randomly selected patient charts were reviewed, with 25 stage III CKD, five stage IV CKD, one stage V CKD, and one stage V CKD post transplantation to create a randomize stratified sample based on the total number of active patient files in the office. The ages of patients ranged from 43 years to 92 years. Only one had a hospitalization in the past year. Three had ER visits.

Unplanned office visits were difficult to track, due to no specific documentation signifying the visit to be unplanned.

Outcomes

Primary and secondary outcomes were employed to evaluate the effectiveness of the EBP project. The primary outcome of this EBP project was the compared number of unscheduled hospitalizations or ER visits from the pre-intervention and intervention groups. Additionally, the total number of encounters post-intervention were compared to the participant's pre-intervention visits within the past year, by utilizing a paired *t* test. The secondary outcome was participant user satisfaction with the mobile application at the conclusion of the intervention. Participant user satisfaction was scored utilizing a Likert scale and means were compared. In addition to collection of the number of unscheduled hospitalizations or ER visits, the number of contacts with the provider or office through phone calls, mobile app usage for imputing symptoms, and office visits were also collected. BP and weights were analyzed by trending.

Time

In collaboration with the project site facilitator, the projected timeline of this EBP project was determined by the literature review, constraints of the project leader's allowable time, as well as the project site facilitator request. The duration of intervention in the reviewed literature most frequently lasted three to six months (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, Marcolino et al., 2018, and Whitehead & Seaton, 2016). Implementation for this EBP project began September 1st, after IRB approval. The project strived to continue to invite participants to join until a number of 50 participants was reached, but due to time constraints, participant invitation closed October 30th. The project duration was planned to last four months.

Protection of Human Subjects

The project leader completed an ethics training program as evidenced by a CITI certificate. Approval for the EBP project was obtained from the Valparaiso University

Institutional Review Board. Confidential participant information was kept locked at the clinical site. Participants' data were de-identified by using codes. A separate master list was used to assign code numbers based on chart name and date of birth. The master list identifying participants was kept in a separate file at the project site.

CHAPTER 4

FINDINGS

This EBP project began by asking the question: how effective is CARELogiQ to self-manage symptoms compared to non-intervention, in order to reduce healthcare utilization and to increase patient satisfaction over a 12-week period. The purpose of this EBP project was to evaluate the efficacy of a CKD mobile application, developed by a local nephrologist, to facilitate symptom management, while increasing patient satisfaction, and decreasing unplanned hospitalizations and ER visits. In order to evaluate the effectiveness of this mobile application, two groups were selected from 180 patients with moderate to severe CKD, a non-intervention group and an intervention group. Unplanned hospitalizations and ER visits related to CKD symptoms were assessed within both groups. Unplanned healthcare utilization was compared within the intervention group pre- and post-intervention, as well as between the non-intervention and intervention groups. The secondary outcome of patient satisfaction was evaluated by a "Satisfaction of Care" survey developed by the project manager. Nine out of 10 participants completed the survey, but not all questions were applicable to all participants. This 12-question survey was administered by a phone call to participants after completion of the 12-week project. Other project outcomes were evaluated by analysis of weekly BP and weight recordings. Utilization of SPSS, version 25.0, facilitated analysis of participant demographic data, as well as primary and secondary outcome data.

Participants

In this chapter, participant characteristics are detailed and evaluated (see Table 4.1). A comparison group of 32 non-intervention participants was obtained from a stratified random sample of the above active patients, ranging in age from 43 to 92 years (M = 71.53, SD = 10.67) was randomly selected to reflect the total percentages in the moderate to severe CKD office population. Twenty-five stage III CKD, five stage IV, one stage V, and one stage V with

transplantation were randomly selected (see Figure 4.1). Of this group, 17 (53%) were male, and 15 (47%) were female (see Figure 4.2). Race/ethnicity for three (9.4%) was “not available”, 18 (56.3%) were “white/not Hispanic”, 9 (28.1%) were “black or AA/not Hispanic, 1 (3.1%) was “black or AA/not available”, and one (3.1%) was “other/not Hispanic” (see Figure 4.3).

A total of 10 individuals from the comparison group participated, ranging in age from 43 to 81 years (M = 67.82, SD = 11.99). Nine (90%) participants were in stage III CKD, and one was (10%) stage IV CKD (see Figure 4.1). Three (30%) participants were male and seven (70%) were female (see Figure 4.2). For race, six (60%) were “white/not Hispanic”, two (2%) were “black or AA/not Hispanic”, one was (1%) “Asian/not Hispanic”, and one (1%) was “not available” (see Figure 4.3).

A chi-square test of independence was calculated comparing the frequency of race between the non-intervention and intervention groups. A significant difference between the groups was not found ($x_2(5) = 4.23$, $p = .517$). Race between the non-intervention group and intervention group appear to come from similar population proportions.

Testing chi-square of independence for gender between the non-intervention group and intervention group did not show a significant difference ($x_2(1) = .92$, $p = .337$). Gender between the groups appears to have the same population proportion.

Comparing the frequency of stage of CKD, a chi-square test of independence did not result in a significant difference between the stages ($x_2(3) = .1.24$, $p = .745$). Non-intervention and intervention participants were not significantly different based on stage of CKD.

An independent-samples t test comparing the mean ages of the non-intervention and intervention groups did not find a significant difference between groups ($t(41) = .965$, $p = .34$). The mean of the non-intervention group (M = 71.53, SD = 10.67) was not significantly different from the mean of the intervention group (M = 67.82, SD = 11.99). Figure 4.4 provides a visualization of age distribution between the two groups.

Table 4.1

Participant Characteristics

Characteristics of:	Non-intervention Group (*n*=32)		Intervention Group (*n*=10)	
	n	%	*n*	%
Stage of CKD				
III	25	78	9	90
IV	5	16	1	10
V	1	3		
V with transplant	1	3		
Gender				
Female	15	47	7	70
Male	17	53	3	30
Race/Ethnicity				
Not Available	3	9.4	1	10
White/not Hispanic	18	56.3	6	60
Black or African American/not Hispanic	9	28.1	2	20
Black or African American/Not Available	1	3.1		
Other/not Hispanic	1	3.1		
Asian/not Hispanic			1	10

Figure 4.1

Comparison of Stage of CKD Between Groups

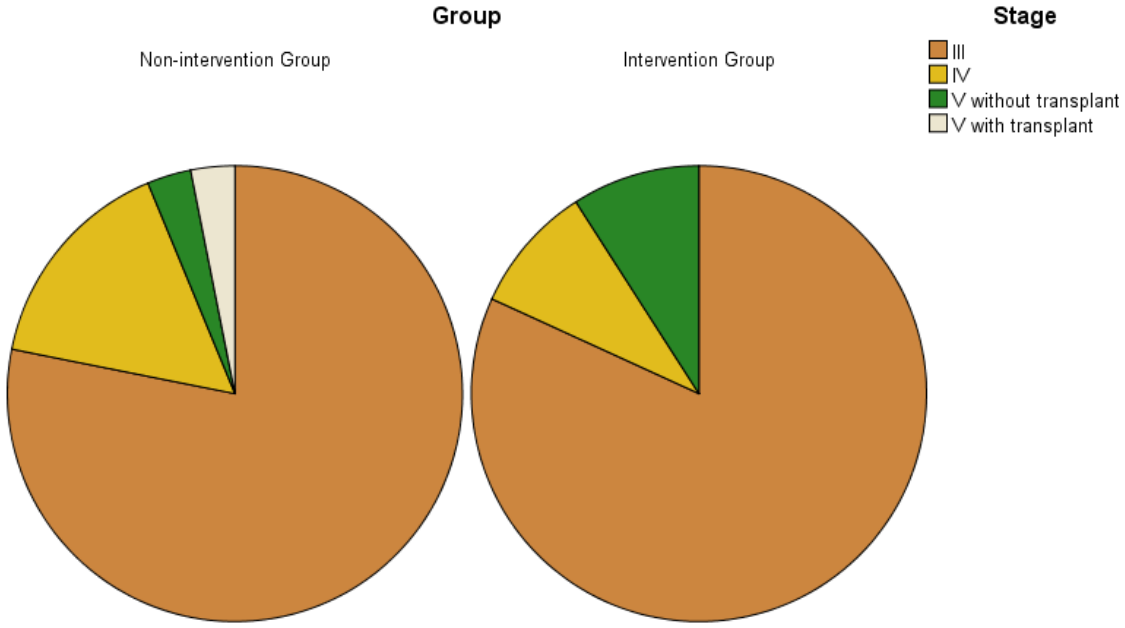


Figure 4.2

Comparison of Gender Between Groups

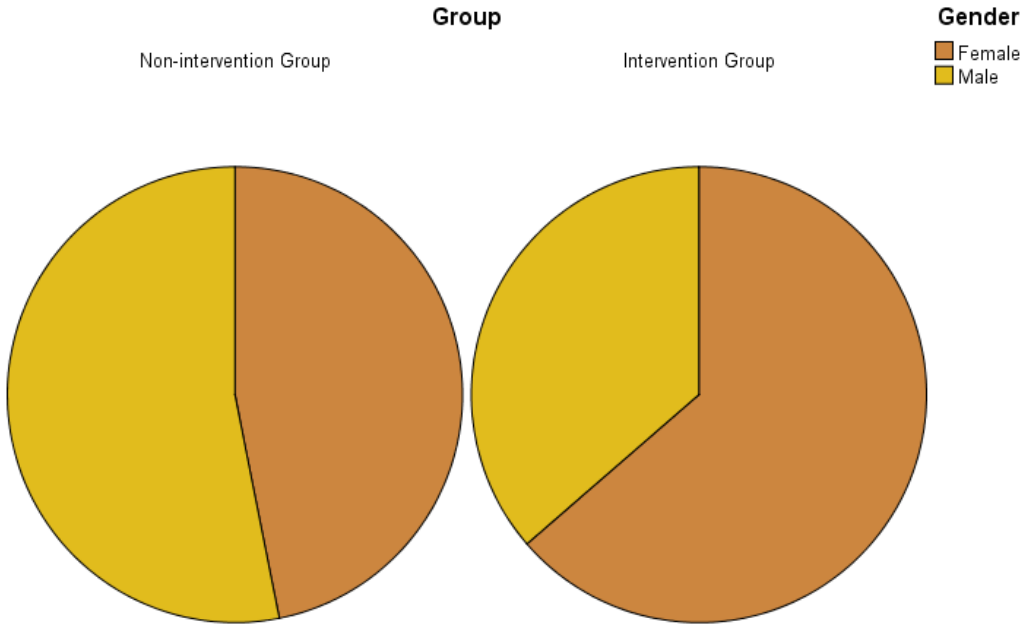


Figure 4.3

Comparison of Race Between Groups

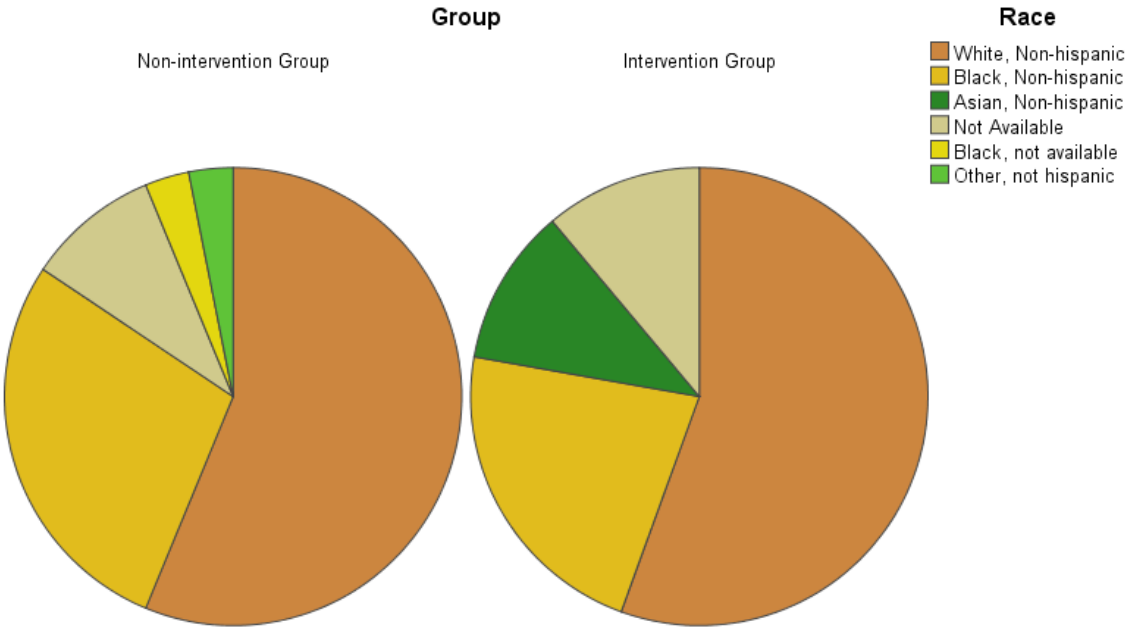
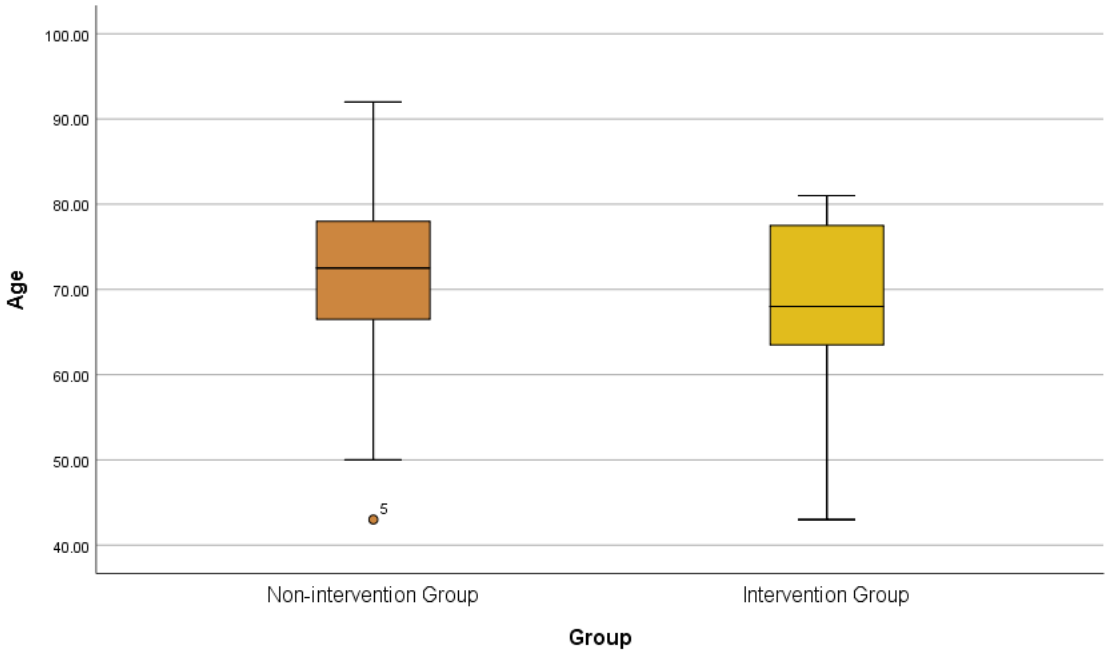


Figure 4.4

Comparison of Age Between Groups



Changes in Outcomes

Statistical Testing and Significance

To determine changes in outcomes, data were analyzed via SPSS, version 25. Primary and secondary outcomes were analyzed. First, participant healthcare utilization was compared between the non-intervention group and intervention group utilizing an independent *t* test. Second, participant healthcare utilization was compared within the same group, pre-intervention vs post-intervention, utilizing a paired *t* test. Description of outcomes, along with tables/figures detailing data, are explained.

The secondary outcome, satisfaction of care, was evaluated by analyzing the responses to 12 questions within the “Satisfaction of Care” survey (see Appendix), calculating a mean score for current use and future use themed questions. Answers in this survey also provide further insight for use of the mobile app.

Other data were analyzed to determine if this mobile application had an effect on BP and weight. These biometric markers were collected pre-intervention, and then weekly for twelve weeks. Line graphs of systolic bp, diastolic bp, and weight were utilized to show a trend over time during the use of the mobile app. The line graphs also depicted group BPs related to a target BP for CKD patients.

Findings

In this EBP project, among patients with moderate to severe CKD, this mobile app (CARELogiQ) was effective to self-manage symptoms in order to reduce healthcare utilization and increase patient satisfaction with care compared to non-intervention over a four-month period.

Primary outcome. An independent-samples *t* test, which compares the means of two unrelated samples (Cronk, 2018), was planned to assess for changes in the primary outcome. Out of the 32 participants in the non-intervention group, three had a total of four instances of healthcare utilization. There were zero instances of healthcare utilization in the intervention

group. An independent-samples *t* test comparing the mean healthcare utilization of the non-intervention and intervention groups did not find a significant difference between groups ($t(40) = .930$, $p = .36$). The mean of the non-intervention group ($M = 0.125$, $SD = 0.42$) was not significantly different from the mean of the intervention group ($M = 0.00$, $SD = 0.00$). While there was not a statistical difference, the absolute number of HU was fewer in the intervention group than the non-intervention group.

A single-sample *t* test, which compares means within a single sample (Cronk, 2018) was intended to analyze the interventional group both pre-mobile app use and post-mobile app use. However, the interventional group did not have healthcare utilization pre- nor post-app use. Due to the lack of variance in scores within the group, the planned testing could not be utilized (Cronk, 2018).

Secondary outcomes. Secondary outcome assessment included measurement of participant satisfaction of care while utilizing CARELogiQ. The satisfaction survey was developed to evaluate satisfaction with current use of CARELogiQ and to explore features desired for future use of the app.

Satisfaction with mobile app. The 12-question satisfaction of care survey presented at the conclusion of the four-month EBP project aided in evaluating what participants thought about the mobile app (see Table 4.2). Four questions on the survey asked participants about their reporting of symptoms in the app. Three participants reported symptoms in the mobile app, with next day or less response time from the physician. One participant did not receive a response. Of the three participants, satisfaction with physician response time resulted in participants being “very satisfied” ($M = 5$, $SD = 0$, $n = 2$) with physician response time. Questions five and six were specific to education and asked if participants were satisfied with the Kidney Smart© class and if they thought it would be helpful to receive educational information through the app. Participants more than agreed that the Kidney Smart© class was satisfactory ($M = 4.6$, $SD = 0.548$, $n = 5$). Participants more than agreed that receiving

educational information through the app would be helpful (*M* = 4.33, *SD* = 0.71, *n* = 9). Question seven and eight addressed biometric reporting and asked if participants were satisfied with weekly BP and weight reports to the project leader and would it be helpful to report weekly BPs and weights through the app. Participants were more than satisfied with reporting weekly biometrics to the project leader (*M* = 4.67, *SD* = 0.5*, n* = 9). Participants more than agreed that it would be helpful to input biometrics into the app (*M* = 4.67, *SD* = 0.5*, n* = 9). Questions nine and ten addressed targeted reminders. Participants were more than satisfied inputting appointment times into the app (*M* = 4.75, *SD* = 0.46, *n* = 8). Participants agreed that receiving medication reminders through the app would be helpful (*M* = 3.22, *SD* = 1.79, *n* = 9). Question 11 evaluated the overall satisfaction with the mobile app. Participants were somewhat satisfied utilizing CARELogiQ (*M* = 3.6, *SD* = 1.14*, n* = 9). Suggestions to add to or change in the mobile app were solicited in question 12. Two common themes emerged; increase functionality of the app and improve communication through the app.

Current use. Questions five, seven, nine and 11 evaluated current use of the mobile app regarding education, biometric reporting, reminders, and overall mobile app utilization. Participants were asked to rate their level of satisfaction utilizing a Likert scale of strongly disagree (1) to strongly agree (5). Figure 4.5 illustrates the findings. Overall, participants appeared to be satisfied with current use of the mobile app.

Future use. Questions six, eight, and 10 evaluated future use of the mobile app regarding education, biometric reporting, and reminders. Participants were asked to rate their level of satisfaction utilizing a Likert scale of strongly dissatisfied (1) to strongly satisfied (5). Figure 4.6 illustrates the findings. Participants appeared to be satisfied with the opportunity of a future use of the app to provide education and the ability to record weekly biometric data. The mean response to participant satisfaction with future use of reminders was somewhat satisfied.

Blood pressure and weight control. This EBP project also afforded the opportunity to track weekly BP and weight. According to the NKF (2010), a target BP for CKD patients is

recommended below 130/80mmHg to slow progression of CKD. A line graph was used to exemplify BPs over the 12-week intervention period (see Figures 4.7 and 4.8). As demonstrated, most systolic BP readings were above the recommended 130mmHg line, with approximately three participant systolic BPs below the recommending reading. Abnormally elevated BPs were reported to the nephrologist for medical evaluation.

Diastolic BPs demonstrated the majority of readings were below the 80mmHg recommended threshold; however, three participants were consistently above this threshold.

Weekly weights were the most consistent of the readings (see Figure 4.9). As seen in the figure, three participants are at or above 250 pounds. It is reasonable to suggest that these participants are obese. The majority (70%) of participants fall below 200 pounds. Height and BMI were not collected, so this graph does not evaluate obesity, but illustrates the consistency of weights. Rapid weight changes in CKD can signify a problem with fluid balance and edema (NKF, 2010). None of the participants required treatment due to rapid weight gain or loss.

Table 4.2

Satisfaction Survey for the Mobile App Usage

Question	*M*	*SD*
Current Usage		
5. How satisfied were you with the Kidney Smart© education class? (*n* = 5)	4.6	0.55
7. How satisfied were your with reporting your blood pressure and weight to the project leader every week? (*n* = 9)	4.67	0.5
9. How satisfied were you with adding your upcoming appointments to the mobile application for appointment reminders? (*n* = 8)	4.75	0.46
11. Overall, how satisfied were you with the mobile application? (*n* = 5)	3.6	1.14
Future Usage		
6. It would be helpful to receive educational information through the app. (*n* = 9)	4.33	0.71
8. It would be helpful to be able to add your blood pressure and weight into the app on a weekly basis. (*n* = 9)	4.67	0.5
10. It would be helpful to receive medication reminders through the app. (*n* = 9)	3.22	1.79

Figure 4.5

Satisfaction of Current App Use

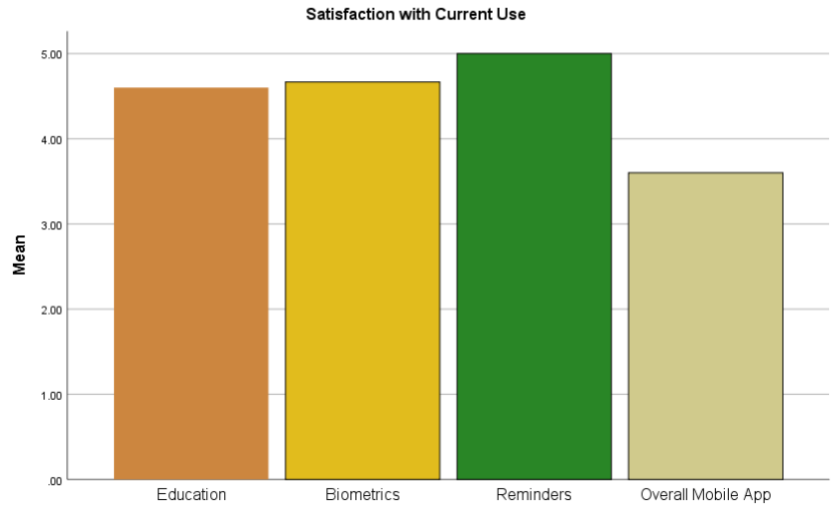


Figure 4.6

Agreement of Future App Use

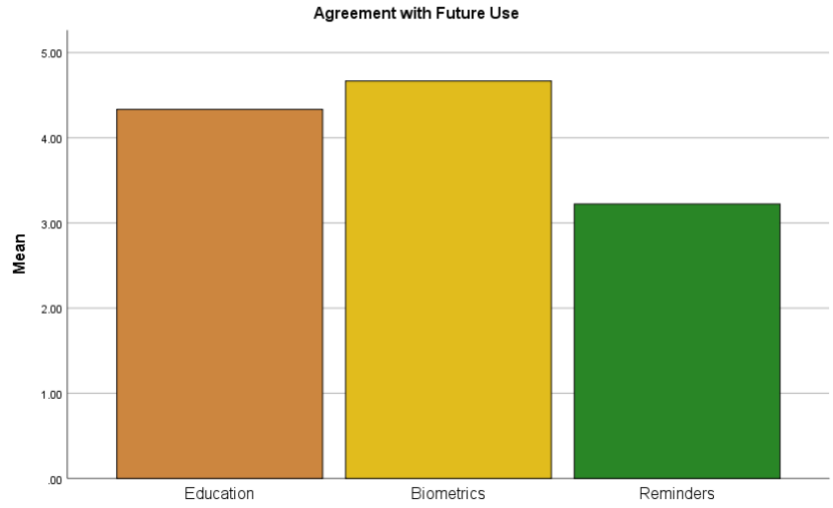


Figure 4.7

Intervention Group Systolic BP Trend

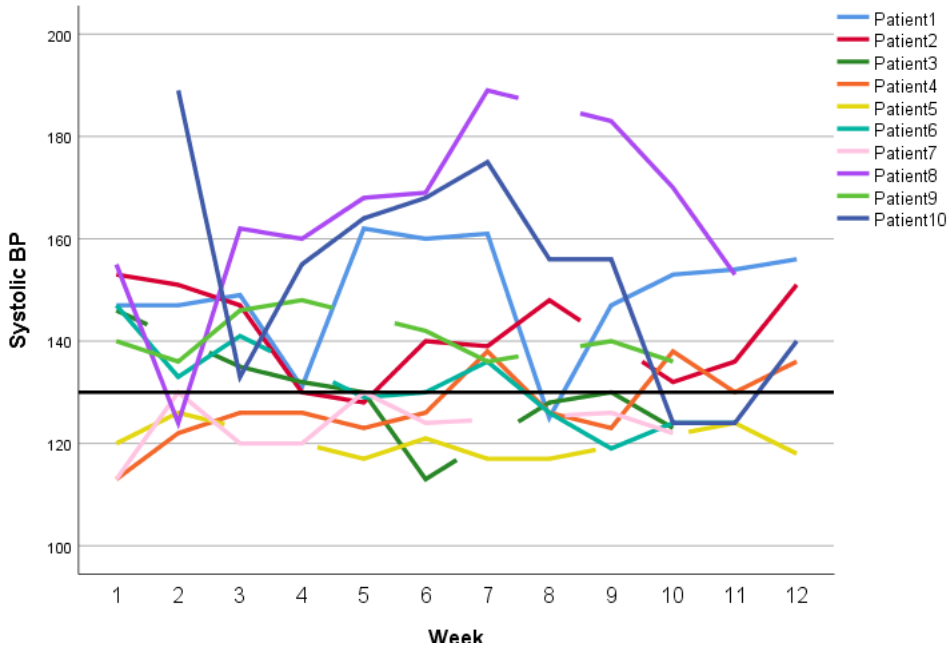


Figure 4.8

Intervention Group Diastolic BP Trend

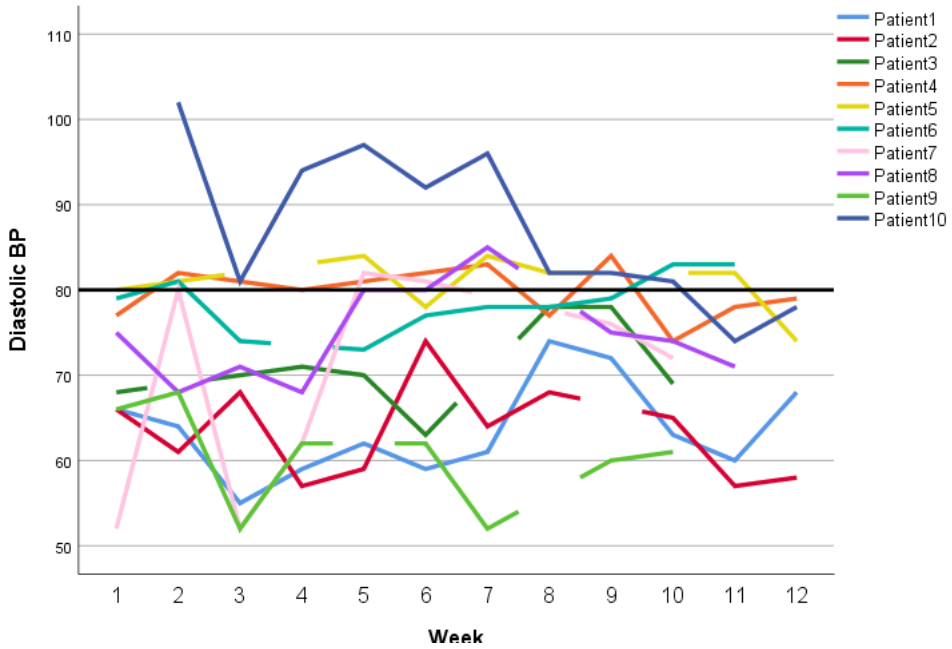
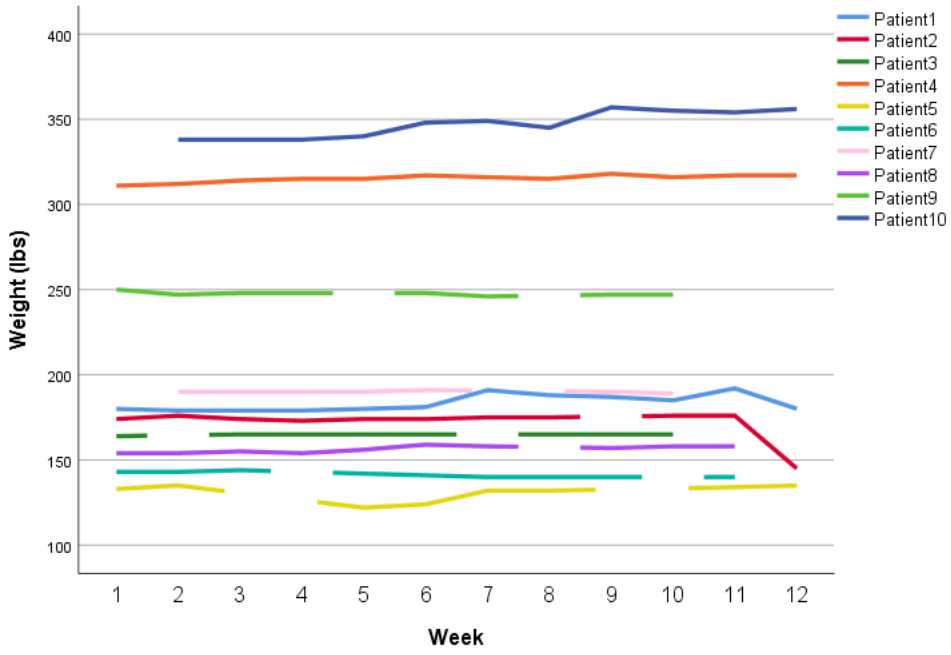


Figure 4.9

Intervention Group Weight Trend



CHAPTER 5

DISCUSSION

This EBP project set out to evaluate the effectiveness of a mobile app to facilitate symptom management in order to increase patient satisfaction and decrease healthcare utilization. In this chapter, the data from Chapter 4 will be interpreted, along with an evaluation of the EBP framework, strengths and weaknesses of the EBP project, and implications for future use related to clinical practice, theory, research, and education.

Explanation of Findings

The primary outcome evaluated in this EBP project was measuring healthcare utilization after use of CARELogiQ. As seen in the preceding literature (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, Marcolino et al., 2018, and Whitehead & Seaton, 2016), common themes of communication, reminders, telemonitoring, and education were utilized to improve symptom management, resulting in decreased healthcare utilization. While not statistically significant, the decrease in healthcare utilization in the intervention group is of clinical significance. The secondary outcome evaluated participant satisfaction using CARELogiQ. Consistent with Alessa et al. (2018) and Lee et al. (2018), participants were satisfied using CARELogiQ in this EBP project.

Applicability of the EBP Framework

The step-by-step approach of the Stetler model facilitated the implementation of this project (Stetler, 2001). The initial step of the model, preparation, began by guiding the identification of a problem requiring change. The development of a mobile app, and subsequent request to launch, spurred the review of the literature. It was then established that high healthcare costs, negative health outcomes, and poor quality of life from CKD (Donald et al., 2018) led to the question whether employment of a mobile app to manage symptoms could decrease unscheduled healthcare utilization. A PICOT question was developed, and a search

strategy was prepared seeking the highest levels of evidence to support this project. The validation phase of the model guided the evaluation and appraisal of the evidence, resulting in a determination of fit for use and leading to the comparative evaluation/decision-making phase. Synthesis of the evidence and evaluation of commonalities were completed, generating best practice recommendations. A decision was made to employ the recommendations to change practice by utilizing the mobile app to aid participants in self-management of CKD. The translation/application phase was fulfilled by formulating a detailed plan of change and acting upon that plan in the practice setting. Lastly, the evaluation phase was comprised of evaluating the outcome data to determine if the practice change led to meeting the outcome goals of increased patient satisfaction and reduced healthcare utilization.

The Stetler model allowed for an ease-of-use implementation of this project by utilizing a step-by-step approach. The Stetler model was advantageous as a framework due to possessing the flexibility to integrate research into practice on both a formal and informal level, as well as individually or organizationally (Stetler, 2001). The highest evidence was formally integrated in this project as evidenced by a formal change in office procedure for project participants. Due to the project leader implementing the majority of the project, this practice change was more individually applied.

The first phase of the model allowed for consideration of external factors to influence identification of EBP activities (Stetler, 2001). The developer of CARELogiQ was a major influence in pursuing this EBP project. Another strength of this model was the ability to accept or reject evidence based on clinical significance, rather than the strength of the evidence (Phase 2) (Stetler, 2001). Due to inclusion of qualitative studies, one systematic review discussed in Chapter 2 was not as strong as other evidence utilized in this project, but the clinical significance of the evidence contributed to the overall support of this project. In addition, some evidence was not specific to CKD, but to chronic disease. This evidence was determined to be vital to this project, and included based on “fit of setting”, or the similarity of the sample and

study environment to the project population and setting (Stetler, 2001). In the decision-making phase (Phase IV), decisions on what evidence to use or how to utilize evidence are practitioner-level decisions (Stetler, 2001). The project leader extrapolated the components of best practice from the literature and developed individual vehicles to employ components to complement the current functionality of the app. Education was delivered via the Kidney Smart© classes, reminders were delivered via weekly phone calls, and telemonitoring was obtained through weekly phone calls. The fourth phase of the model allows for consideration of need for appropriate, reasoned variation (Stetler, 2001). This allowed for changes to the inclusion criteria, including the change from smartphone to smart device and opening participation to patients in a second practice location. In the final phase, Stetler (2001) allows for a "consider use" option. While the outcome of this project did not yield statistically significant results, stakeholders can "consider use" by making alterations to the project based on project findings and recommendations, and implement a pilot project.

A limitation of the Stetler model was the dependence on the competency, knowledge, and skill level of the project leader. Without these characteristics, research application is vulnerable to not being appropriate, effective or evidence-based (Stetler, 1994). While the comprehensive step-by-step approach is a strength of the model, the project leader found the complexity of details in each step overwhelming and a weakness due to the amount of time spent attempting to comprehend the intricacies of these details.

Strengths and Limitations of the DNP Project

Strengths and weaknesses were identified upon evaluation of this EBP project. While high level, high quality evidence directed the implementation of this project, due to functionality not yet employed by the app, some limitations were identified. A more detailed discussion of strengths and weakness is continued below.

Strengths

Strengths of this project included strong evidence to support the practice change. The higher the level and quality of the evidence, the stronger the recommendation represents best practice (Dang & Dearholt, 2017). Most of the literature reviewed was level I (Jeddi et al., 2017, Lee et al., 2018, and Whitehead & Seaton, 2016) and level II (Kitsiou et al., 2017, and Marcolino et al., 2018), with one level III piece of evidence (Alessa et al., 2018) that was deemed of high clinical significance. All evidence was of high quality (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, Marcolino et al., 2018, and Whitehead & Seaton, 2016). These characteristics led to concrete recommendations to guide the practice change. The EBP model, Stetler, was another strength of this EBP project. The step-by-step approach of this model provided a concrete framework to develop this project. It was also advantageous to have an invested project facilitator who was supportive of a successful EBP project implementation. The site facilitator, the nephrologist who developed the CARELogiQ app, championed its use in this EBP project. Having access to the mobile app creator allowed for ease of access to answers regarding the functions of the mobile app. The practice of this nephrologist provided a setting conducive to a successful project. The office staff was invaluable for accessing patient information in the EMR system.

Best practice recommendations derived from the literature included communication (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, Marcolino et al., 2018, and Whitehead & Seaton, 2016), reminders (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, and Marcolino et al., 2018), telemonitoring (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, and Marcolino et al., 2018), and education (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, and Marcolino et al., 2018) with an app. CARELogiQ provided a platform for participants to report symptoms through the app, without needing to contact the office. This process of reporting symptoms allowed for direct communication with the nephrologist, compared to current office procedure of office staff writing down a patient message and attaching it to a clipboard to be reviewed at the end of the day.

The communication feature also gave participants more control over how symptoms were reported to the nephrologist, by having participants answer questions of duration and severity within the report. There was no need to rely on office staff to transcribe and report an accurate message from the participant.

While telemonitoring relied on weekly, manual checks of BP and weights, the collection of these recordings benefitted participants. Several participants were identified by the project leader as having abnormal BP readings that required medication adjustments. These checks resulted in participants having closer attention given to the management of their BP between office visits. This project also identified a trend in the majority of participants' systolic BPs being above the recommended value for CKD. The telemonitoring component of best practice can be enhanced with the addition of a device to link to CARELogiQ to directly record and transmit BPs and weights, allowing for tighter control of these biometric markers.

While the education component of best practice recommendations was not yet functionable through the CARELogiQ app, the Kidney Smart© education class provided another strength to this project. Participants signed up for a 90-minute, group structured class at an outside facility, conducted by an outside educator. Participants who attended this class were highly satisfied with the information they obtained and benefitted from increased knowledge of their disease. Most participants stated they would like an education component within CARELogiQ. Incorporation of an educational section in CARELogiQ could potentially provide the same level of satisfaction or greater, which may result in better self-management of their CKD.

This EBP project also identified another patient care issue that could be improved. As stated previously, of the 180 patients in this setting with moderate to severe CKD, 37 (21%) did not have their race identified. Due to African Americans having higher average muscle mass and creatinine generation rate, the GFR of African Americans is higher than non-African American patients (NKF, 2014). Reports of GFR not adjusted for African American patients

would not accurately reflect the severity of CKD in the African American patient. It is important to collect complete demographics, including race, to accurately interpret lab results of patients.

Limitations

CARELogiQ was still in development, resulting in all functionality not being available as had been projected. Best practice recommendations for this EBP project included use of automatic reminders; however, CARELogiQ only allowed for the manual input of upcoming appointment dates. It would be beneficial for patients to have upcoming appointments automatically populate in the app for accuracy and completeness. Other reminders that would have been appropriate to incorporate from the best practice recommendations included medication reminders and biometric evaluation reminders. For this project, the project leader augmented this concept by reminding participants to enter upcoming appointments in the app, to take their medication as scheduled, and to log their BP and weights at least weekly for collection of these data in the weekly project leader phone call to participants. Incorporation of these features into the CARELogiQ app platform would be potentially beneficial.

Another limitation of this project was the low number of participants. While the non-intervention group was based on the number of total patients in the clinic, the intervention group was not limited beyond the inclusion/exclusion criteria. Many patients either did not have access to a smartphone or tablet, felt uncomfortable using mobile apps, or were not interested in participating in the project. When no access to a smartphone was identified as a common limitation to enrolling participants, opening up the inclusion criteria to include smart devices, such as a tablet was beneficial. Future EBP projects may benefit from office supplied devices obtained by funds from a grant. Participants who were uncomfortable with using mobile apps were given the opportunity to download CARELogiQ in the office with assistance from the project leader, although some potential participants still declined the invitation due to this issue. The project leader met patients on the same day that the invitation was extended to participate in the project. Patients who stated they just were not interested in participation may have been

more willing to participate if the project was introduced to them by staff with whom they already had a clinic relationship.

The timeframe of the project was also a limitation. Initially, only one practice location schedule was utilized to invite participants. In an effort to increase the number of potential participants, a second practice location's schedule was added. This site added another half-day clinic per week. In total, the nephrologist was scheduled three half-days per week. The limited number of office hours, along with the four-month duration of the project may have limited the source of potential participants. Evidence used in this project had durations of a few minutes to 24 months, with most studies identifying durations lasting up to 12 months (Alessa et al., 2018, Jeddi et al., 2017, Kitsiou et al., 2017, Lee et al., 2018, Marcolino et al., 2018, and Whitehead & Seaton, 2016). Having more scheduled clinics per week to invite participants would potentially have resulted in a larger number of participants in the intervention group.

Overall, the lack of functionality of the mobile app resulted in limitations of the project. While the mobile app allowed participants to report their symptoms to their provider through the mobile app, two-way messaging through the mobile app was not possible. Participants were able to manually input upcoming appointments into the mobile app, but appointments did not automatically populate in the mobile app at the time an appointment was scheduled. Participants were also frustrated by difficulty signing up for the initial app usage. Some participants were able to sign up, but then unable to sign in to the app after previously being able to do so. To overcome the limitations of the mobile app, the project leader called participants weekly by phone to collect BP and weight readings. It was not possible to collect these data by text messaging, through the mobile app, or by a direct telemonitoring device connected to the smartphone or tablet. The mobile app also lacked the ability to store these biometric readings. Lastly, the mobile app did not provide a platform for participants to receive any direct educational information, either through links to outside sources, or educational

references within the mobile app. The addition of these features would be an added benefit to patients to review educational materials at any time.

Implications for the Future

Practice

Utilizing CARELogiQ to self-manage symptoms may be effective to reduce healthcare utilization and increase patient satisfaction of care. Providers can use CARELogiQ to empower patients to be more self-sufficient. Patients would have more control over management of their CKD. By reporting symptoms directly into the app, providers would be able to receive information in real time, allowing for the provider to determine the level of urgency requiring a response. Internalizing telemonitoring functionality could provide greater control over BP and weight between office visits. Storing biometric data in the app could allow for easy review of biometric trends during office appointments. The data gathered in this project have demonstrated a trend of systolic BPs higher than the recommended value. Providers could use this app to aid in the normalization of BPs. Appointment reminders could reduce the amount of missed appointments, and reminders for medication and biometric evaluations could improve care as well by serving as a reminder to take scheduled medications and check BPs and weights. The education component of the app could compliment and reinforce the educational information the provider is giving to the patient during office visits. The app could provide “tabs” for education within the app, links to other sources of education outside the app, and provide resources for additional education such as Kidney Smart©. With increased functionality, CARELogiQ has the potential to aid providers in the management of CKD. It may also be beneficial to have advanced practice registered nurses as dedicated CARELogiQ navigators, managing patient care through the CARELogiQ app within the institution implemented.

Model/Framework/Theory

The Stetler model provided a concrete framework for this EBP project. This model provided a step-by-step approach to guide this project through the five phases, with the ability to

loop back to previous phases as needed to allow for variations. Projects that are implemented mainly by an individual project leader are well-suited for this model. This model also encourages clinically significant evidence to be considered in addition to evidence graded as strong. Future EBP projects would benefit from using the Stetler model as an EBP framework for similar projects due to the guidance through each step from identification of a problem, review of the literature, synthesis of the evidence, implementing the plan, and evaluation of the project. Further guidance could be attained by the addition of a theoretical framework. Although this EBP project did not utilize a theoretical framework, several theories may be of assistance in future EBP projects.

Research

While the findings of the primary outcome of this project were not statistically significant, this EBP project can contribute to future research and future EBP projects. This EBP project is the first to evaluate use of CARELogiQ. Strengths and limitations of the project can be utilized to make changes to the app functionality and design of a future EBP project. A pilot project could also be implemented based of the results of this EBP project, potentially leading to statistically significant findings, allowing for commercial use of CARELogiQ.

Education

This EBP project highlighted some important areas of needed education. Staff should be educated on the need to identify race in all demographic data collected on patients. Access to this demographic data is imperative to accurately diagnose the stage of CKD for individual patients and monitor their clinical progress.

For patients, the education component that could be built into CARELogiQ would be beneficial by having information about their disease at their fingertips. The mobile app could also provide a resource link for additional education opportunities. Attendance of Kidney Smart© classes should continue to be strongly encouraged.

Conclusion

The purpose of this project was to initiate the use of CARELogiQ in an outpatient CKD clinic to positively affect CKD self-management resulting in increased patient satisfaction of care and decreased hospitalizations and ER visits. While healthcare utilization did decrease in the intervention group, this was not statistically significant. Having a larger intervention sample size, in addition to a longer duration of time to invite participants, may have contributed to significant outcomes.

In response to the secondary outcome, patients were satisfied using CARELogiQ, although attenuated by lack of some available functions and trouble with logging into the app. With further development of CARELogiQ, patient satisfaction could only be improved with increased functionality of the mobile app. Future CARELogiQ EBP projects may lead to significant outcomes with a larger sample size, a longer implementation time, added functionality of CARELogiQ, and a smart device provided to participants who did not have their own device. By improving symptom management, CARELogiQ could reduce HU, leading to a positive impact on CKD burden.

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BIOGRAPHICAL MATERIAL

Ms. Zamora graduated with her Bachelor of Science in Nursing in 1996 from Valparaiso University (VU). She worked as a registered nurse in a cardiovascular step-down setting and an intensive care setting before returning to VU to complete her Master of Science in Nursing in 2000, and her Post-Master's Family Nurse Practitioner Practicum in 2001. She is a board-certified Family Nurse Practitioner through ANCC and has worked in various family practice and specialty settings throughout the past 19 years. She was inducted into Sigma Theta Tau International Honor Society-Zeta Epsilon Chapter in 1996 and has been a member of several other professional nursing organizations during her career, including Society of Nurses in Advanced Practice and American Academy of Nurse Practitioners. In an effort to enhance her personal career and to promote her profession, Ms. Zamora has chosen to pursue her Doctor of Nursing Practice at VU, anticipating a May 2020 graduation. Her abstract, "Efficacy of a Mobile Application in a Chronic Kidney Disease Population", was selected for a poster presentation at The Northwest Indiana Nursing Research Consortium, where she was awarded "Outstanding Graduate Student Poster Presentation".

ACRONYM LIST

BG: Blood Glucose

BP: Blood Pressure

CINAHL: Cumulative Index of Nursing and Allied Health

CKD: Chronic Kidney Disease

CVD: Cardiovascular Disease

DM: Diabetes

GFR: Glomerular Filtration Rate

HCP: Health Care Provider

HF: Heart Failure

HTN: Hypertension

JBI: Johana Briggs Institute

JHNEBP: Johns Hopkins Nursing Evidence-Based Practice Research Evidence Appraisal Tool

KDIGO: Kidney Disease Improving Global Outcomes Initiative

KDOQI: Kidney Disease Outcomes Quality

mHealth: Mobile Technology

NKF: National Kidney Foundation

PDA: Personal Digital Assistant Devices (PDAs)

SMS: Short Message Service

US: United States

USRDS: United States Renal Data System

APPENDIX

Satisfaction of Care Survey

SATISFACTION OF CARE SURVEY

Thank you for your time and effort to participate in our project. Please answer the questions below as best you can. The information will be helpful for future developments of the app. If the question does not apply to you, just answer "NA". Your answers will be anonymous.

1. Approximately, how many times did you report symptoms in the mobile application?
2. What symptom(s) did you report?
3. How long did it take to get a call back for your reported symptom(s)?
4. The length of time it took for a response to your reported symptoms was satisfactory. SD, D, N, A, SA or NA
5. The Kidney Smart© education class was satisfactory. SD, D, N, A, SA or NA
6. It would be helpful to receive educational information through the app. SD, D, N, A, SA
7. How satisfied were you with reporting your blood pressure and weight to the project leader every week? SD, D, N, S, VS
8. It would be helpful to be able to add your blood pressure and weight into the app on a weekly basis. SD, D, N, A, SA
9. How satisfied were you with adding your upcoming appointments to the mobile application for appointment reminders? VD, D, N, S, VS
10. It would be helpful to receive medication reminders through the app. SD, D, N, A, SA
11. Overall, how satisfied were you with the mobile application. VD, D, N, S, VS
12. Do you have any suggestions to add to or change in the mobile application?