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Evaluation of a Protocol Change to Improve Screening of Mineral Bone Disorders in Patients With Stage 3 Chronic Kidney Disease

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Abstract

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Chronic kidney disease (CKD) is a growing worldwide problem. Patients with CKD are at great risk for multiple health problems and ultimately face end stage renal disease (ESRD). One of the problems of concern is the loss of bone mass, termed mineral bone disorders (MBD). The literature reveals that bone mass loss can begin as early as stage 3 CKD. The National Kidney Foundation (NKF) Clinical Practice Guideline (2003), and The Kidney Disease: Improving Global Outcomes (KDIGO, 2009) recommend that persons identified in stage 3 CKD be screened for hypovitamintosis D, elevated intact parathyroid (iPTH) levels, and abnormal calcium and phosphorus levels The purpose of this capstone project was to determine if the use of a prompt on the EMR system would improve the screening of patients with stage 3 CKD for MBD in a primary care setting. Provider prompts for electronic medical records in a primary care setting based upon a critical appraisal of the current literature were initiated.

Contents

Introduction

The goal of this capstone project was to implement a clinical practice guideline (CPG) related to chronic kidney disease (CKD) and vitamin D deficiency in a local primary care practice. This paper outlines a capstone project in a local primary care practice. Persons with CKD have higher rates of morbidity, mortality, and health-care utilization. Additionally they have diminished health related quality of life (QOL) secondary to the multiple health concerns associated with CKD. Early screening of patients at risk for CKD can improve long term health outcomes and improve overall QOL (CDC, 2009). Improving health outcomes for at risk populations is congruent with the goal of the discipline of nursing. This paper includes background and significance of the problem, a review of the pertinent literature, and a detailed description of the proposed project.

Background

Chronic kidney disease (CKD) is a national serious health disease that is associated with increased mortality and decreased quality of life. If left untreated, CKD can lead to end-stage renal disease (ESRD) resulting in dialysis or kidney transplants (Centers for Disease Control and Prevention [CDC], 2007). Eknoyan et al. (2004) also noted that there is an ever increasing incidence and prevalence of patients with renal disease that ultimately require dialysis. Health outcomes for this patient population are poor and health care expenditures are costly. There is an even higher prevalence of patients in earlier stages of the disease with adverse outcomes such as kidney failure, cardiovascular disease, and death.

Definitions

This paper will refer to several key words or terms. It is important that definitions be offered in an effort to provide clarity and meaning to the topic that is being discussed. *Mineral bone disorders* (MBD) can be diagnosed as early as stage 3 CKD. The newest definition for CKD-MBD includes a systematic disorder of mineral and bone metabolism due to CKD and manifested by either one or a combination of 1) abnormalities of calcium, phosphorous, iPTH, or vitamin D metabolism; 2) abnormalities of bone turnover, mineralization, volume, linear growth, or strength; and 3) vascular or other soft tissue calcifications. Consequences of CKD-MBD begin early and are typically progressive. Mineral and endocrine functions are disrupted early in CKD and are critically important in the regulation of bone remodeling (Kiattisunthorn and Moe, 2010). As a result, bone abnormalities are found almost universally in the majority of patients with CKD. These skeletal changes result in an increased prevalence of hip fracture compared to the general population. A hip fracture in a patient with stage 3-5 CKD is associated with a doubling of mortality when compared to the general population. Additionally, these patients suffer from decreased QOL. Raymond, Wazny and Sood (2010) point out that bone abnormalities in this population cause bone pain, increased fractures of the hip and spine, deformities, disabilities, increase hospitalizations and mortality. The early recognition and treatment of this disorder in patients with stage 3 CKD can improve health outcomes and quality of life.

Additionally, it is important to know the proper definition of CKD, specifically CKD stage 3, since this was the targeted patient population for this project. The definition of *stage 3 chronic kidney disease* is an estimated glomerular filtration rate (eGFR) less than 60ml.min/1.73^2 lasting three months or longer despite the cause (Levey et al., 2009). The measurement of eGFR is used to determine the level of kidney function, and then is categorized into five stages using

the Modification of Diet in Renal Disease (MDRD) calculation. This tool was published in 2002 and provides a clear definition of CKD and a classification of the stages (Eknoyan et al., 2004). Stage one is persistent microalbuminuria, and stage five is ESRD, an eGFR of <15 ml.min/1.73m^2. By definition then, MBD can be diagnosed early in the CKD process giving healthcare providers the opportunity to intervene early with education and treatment.

For the project described in this paper, an EMR system was used as a means of delivering a provider prompt as well as to assist the project leader in record reviews and gathering data. An *electronic medical record* is a computerized patient record containing various forms of patient data that is routed through a health care system. Electronic medical records tend to be a part of a local stand-alone health information system that allows storage, retrieval and modification of records (Segen, 2006). Additionally, they can be programmed to offer prompts to providers related to practice specific needs. For this project change a prompt was placed on the EMR. A *prompt* is simply a reminder or cue. The prompt for this project was generated based on patient specific diagnosis codes and served as a reminder or cue for the provider to evaluate the patient for the potential need to screen for MBD.

Prevalence

Global

Chronic kidney disease is a global problem with widely varying prevalence rates, worldwide resource allocation imbalance, and economic implications. According to the World Health Report 2002 and Global Burden of Disease, disease of the kidney is the 12th leading cause of death worldwide with approximately 850,000 deaths annually. Based on a study examining the population-wide prevalence in 13 countries, the four highest prevalence rates of stage 3 CKD are in the countries of Japan (18.5%), Thailand (13.4%), Australia (10.9%), and the U.S. (7.5%).

Unfortunately, resource distribution does not correlate with prevalence. Nahas and colleagues (2005) report that although they represent only 12% of the global population, five countries receive 56% of all renal replacement therapy (RRT). As a result of this inequality, 112 countries representing approximately 600 million people remain without RRT. Some fear that the widespread nature of CKD and the expense of treatment has the potential to overwhelm the limited resources of less "robust" economies (Glassock & Winerals, 2008).

United States

The CDC (2007) analyzed the most recent data from the National Health and Nutrition Examination Survey (NHANES) and estimated that the prevalence of kidney disease in the adult United States population rose 15.9% when 1994 data was compared to 2004 data. Furthermore, they noted that for CKD diagnosis in the general population for 2003-2004, 10.9% had diabetes and 33.6% had HTN. Obesity and dyslipidemia were 26.8% and 38.1 % respectively. Persons with these diseases had a greater prevalence of CKD compared to persons without these conditions. This emphasizes the need to continue to explore the causes of CKD in the U.S. and to implement strategies to decrease the number of persons with this disease.

Current literature indicates a progressive rise in prevalence and incidence rates related to CKD in the U.S. Coresh and colleagues (2007) examined the prevalence of CKD in the U.S. They compared data from the NHANES report from 1988-1994 to more recent data from 1999-2004 and found a statistically significant higher prevalence in each stage of CKD in the 1999-2004 data compared to 1988-1994. By gender, the prevalence for men was 8.2% in 1988-1994 and 11.1% in the 1999-2004 data. For women, the prevalence was 12.1% and 15.0% respectively. With regard to ethnic diversity, the change was from 10.5% to 13.8% among non-Hispanic whites, 10.2% to 11.7% among non-Hispanic blacks, and 6.3% to 8.0% among

Mexican Americans. Levey (2009) noted incidence rates for African Americans and Native Americans to be three and two times greater than for whites respectively. The CDC (2007) reported newly diagnosed ESRD cases for 2006 to be 61,202 in males and 48,428 in females. This was based on the general population.

Finally, researchers have identified age as a direct risk factor for CKD. The CDC (2007) reports that for people ≥60 years in all stages of the disease, there was a 39.4% prevalence of CKD. Morbidity and Mortality Weekly Report (MMWR) March of 2007 reported from 1999-2004 there were 20.3% of US adults ≥60 years of age with stage 3 CKD. Levey (2009) followed by stating that the incidence rates for CKD in people ≥65 years of age are three times that of younger people. Therefore, age alone is a growing risk factor for renal disease given the aging population.

West Virginia

In April 2006, the West Virginia Department of Health and Human Resources (DHHR) issued a report concerning the impact of CKD in West Virginia. Unfortunately, state specific estimates for CKD were unavailable at the time of the report and still remain scarce. The focus of this report was on ESRD and the data was obtained by ESRD Network Organizations and based on a rate per a population of 1,000,000. Over at ten year time frame from 1994-2003, the incidence rate of ESRD was consistently higher in West Virginia than in the U.S. However, with respect to prevalence rates for ESRD, between 1994 and 2000 the national rates were higher than in the state. Finally, in 2001, the state's rate surpassed the national rate and has been consistently higher since, though the difference is slight. The CDC (2009) identified the incidence rate for ESRD in West Virginia as 337.91 per million and death rates due to kidney disease as 20.2 per million.

According to the CDC (2009), risk factors for West Virginians with a diagnosis of CKD in 2003-2004 were as follows: 7% had diabetes, 24.8% had HTN, 23.1% were obese, and 33.1 % had dyslipidemia. The CDC (2009) reported that in West Virginia with respect to gender for a diagnosis of ICD-9 code 585 (renal disease), 46.2% were male and, 53.9% were female, this was based on the general population for 2006. While the DHHR (2006) report did not examine gender differences for ESRD, they did report on the death rate in West Virginia due to kidney disease for the year 2004. There were 568 deaths in the state, 244 were men and 324 were women. Of these totals, 78% were attributed to renal failure with 20% as a result of HTN with renal disease. Most of these deaths occurred among West Virginias aged 65 or older.

Causes of CKD

Chronic kidney disease is caused by other disease processes. Hypertension (HTN), and diabetes are the most common causes of CKD (Levey et al., 2009), while glomerulonephritis and polycystic kidney disease are the third and fourth most prevalent causes (National Kidney Foundation, 2003). Initially caused by another disease or disorder, CKD eventually leads to other serious health problems.

Complications of CKD: Mineral Bone Disorders

Disturbances of mineral and bone metabolism are complications of CKD. These disorders are abundant in this patient population and are a documented cause of morbidity, decreased quality of life, and extra-skeletal calcification that is associated with increased cardiovascular mortality. The disturbances have been termed mineral bone disorders (MBD). Moe et al. (2006) addressed the complications of disturbances in mineral and bone metabolism in patients with CKD. They identified that the most common forms of MBD are attributable to abnormal iPTH levels in patients with CKD. Gesek and Desmond (2008) noted that there is a negative correlation

between active vitamin D levels and iPTH levels in patients not yet on dialysis. Most commonly, this is seen as vitamin D deficiency or insufficiency. Therefore, evaluation of these disorders early in the disease process becomes essential. In 2009, The Kidney Disease: Improving Global Outcomes (KDIGO) committee redefined MBD to be inclusive and specific to CKD bone mineral disorders (CKD-BMD) and to provide a more global definition (Nickolas, Leonard, & Shane, 2008). The newest definition for CKD-BMD includes a systematic disorder of mineral and bone metabolism due to CKD and manifested by either one or a combination of 1) abnormalities of calcium, phosphorous, iPTH, or vitamin D metabolism; 2) abnormalities of bone turnover, mineralization, volume, linear growth, or strength; and 3) vascular or other soft tissue calcifications. KDIGO (2009) recommends that the initial screening begin with biochemical testing.

Ketstenbaum and Belozeroff (2007) conducted a systematic review of the literature related to mineral metabolism disturbances in patients with CKD. They reviewed 27 observational studies and clinical trials. They determined that mineral metabolism disturbances were characterized by low serum levels of activated vitamin D and calcium, and high levels of phosphorous and iPTH hormone. If left untreated, these disturbances can progress to CKD mineral and bone disorders which often leads to bone abnormalities and/or extra-skeletal calcification. They concluded that there was evidence that patient outcomes for this population could be improved through increased awareness of the MBD guideline set forth by the NKF K/DOQI guideline.

Inaguma, et al. (2008) examined the relationship between serum vitamin D levels and mortality in patients with pre-dialysis CKD. They conducted a longitudinal observational study that included 226 patients with stage three and four CKD. Participants were placed into one of two arms; those with vitamin D levels < 20 pg/ml and those > 20 pg/ml. Comparison was done

on all cause mortality and cardiovascular mortality between the two groups by using a survival curve. The findings of the study suggested that serum level of vitamin D was associated with all-cause mortality in patients with CKD stages 3 and 4.

Evidence found by the critical appraisal of one meta-analysis (Stone et al., 2002), five RCTs (Feldstein et al., 2006; Filippi et al., 2003; Lafata et al., 2007; Lester et al., 2005; Sequist et al., 2005), two quasi-experimental studies (Larson et al., 2009; Goetz et al., 2008) and one interventional study (Fiks et al., 2007) supports the implementation of a prompt in an EMR system to improve management of chronic illness and increase health promotion. Although there were multiple practice settings explored related to the use of prompts, they consistently demonstrated that the use of an EMR prompt serves to improve health outcomes in a chronically ill population.

Significance

Chronic kidney disease is a progressive chronic illness affecting thousands of patients worldwide and is associated with increased morbidity and mortality. There is an increasing incidence and prevalence of patients with CKD, many of whom will eventually require dialysis. Approximately 20 million American adults have been diagnosed with CKD with an additional 20 million at risk. Annually there are an estimated 90,000 new cases diagnosed in the United States. Due to this, CKD is threatening to reach epidemic proportions thus overwhelming already limited resources for this population, especially patients in less "robust" economies. One of the factors to consider in this population is vitamin D deficiencies. Vitamin D deficiency is detected in early phases of CKD especially when the eGFR falls below 60ml/min/1.73^2, thus resulting in mineral metabolism disturbances. Early detection and treatment of vitamin D deficiency in this population can result in improved health-care outcomes such as decreased bone and muscular

pain, improved bone strength, decrease in fragility fractures, and overall improvement in QOL. Unfortunately, these patients are not being screened early in the disease process, resulting in poor healthcare outcomes. This capstone project focused on early screening within a primary care setting of patients with stage 3 CKD who may be at risk for MBD.

Literature Review

Search Strategy

This literature review was conducted outside the realm of CKD since there are no available studies related specifically to EMR prompts and CKD. The search strategy for this paper was driven by the PICO question "Does provider education and a prompt on the EMR increase ordering of vitamin D, iPTH, calcium, and phosphorus levels in patients with stage 3 CKD in primary care?" The databases searched included: CINHAL, EBSCO host, MEDLINE, PUBMED, National Guidelines Clearinghouse, and the Cochran Library. Limitations were set for years, January 1999 through 2009, and for English language. The literature was explored using keywords from the PICO question. To begin, the terms information technology and healthcare rendered 302 hits. To narrow further, the key word chronic disease was added for 291 results. This resulted in a total of 593 articles. To continue to narrow this search, keywords were used in combination. Physician reminders and practice change were searched and resulted in 33 hits. Next, clinical practice change and EMR rendered 12 hits. Computer reminders and compliance resulted in 12 hits and finally, systematic review and information technology and medical care rendered 62 hits. The original 593 articles were ultimately narrowed to 116 articles. Using the method of snowballing, 14 additional articles were selected. After review of these 130

articles, 18 articles were determined to be relevant to the PICO question and were extracted for review.

Criteria for inclusion included keywords: electronic medical record (EMR), reminder, prompts, physician prompts, clinical reminders, information technology interventions, either in the title or abstract. These 18 articles and two clinical practice guidelines (CPGs) were reviewed for inclusion. Nine articles and two CPGs met these criteria and were chosen as the strongest sources of evidence. Of the nine articles chosen one was a meta-analysis (Stone et al.,2002), five were randomized control trials (RCT), (Feldstein et al., 2006; Filippi et al., 2003; Lafata et al., 2007; Lester, Grant, Barnett, Cheuh, 2005 & Sequist et al., 2005), two were quasi-experimental studies (Goetz et al., 2008 & Larson, Ko, & Dominitz, 2009), one was an interventional study (Fiks, Grundmeier, Biggs, Localio, & Allessandrini, 2007) and two were CPGs (KDOQI, 2003; & KDIGO 2009).

The literature review for this project was conducted in a systematic method using an evidence pyramid related to the hierarchy of literature to ensure the highest level of evidence was obtained. To begin, The Scottish Intercollegiate Guidelines Network (SIGN, 2008) checklist for validity was used to appraise the meta-analysis (Stone et al., 2002) and the five RCTs (Feldstein et al., 2006; Filippi et al., 2003; Lafata et al., 2007; Lester et al., 2005; Sequist et al., 2005). The CPGs (KDOQI, 2003; KDIGO, 2009) were appraised using the Appraisal of Guidelines for Research and Evaluation (AGREE, 2001). The remaining articles, two quasi-experimental (Goetz et al., 2008; Larson et al., 2009) and one interventional study (Fiks et al., 2007), were assessed for validity using the Quantitative Literature Review Worksheet (Larrabee, 2009).

Clinical Practice Guidelines (CCPGs)

Two CPGs were included in this literature review: the *Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification, and Stratification* (2003) developed by the Kidney Disease Outcomes Quality Initiative (KDOQI) and the *Guidelines for Chronic Kidney Disease—Mineral Bone Disorder* (2009) developed by the Improving Global Outcomes (KIDGO) foundation. Both guidelines were assessed using the Appraisal of Guidelines for Research and Evaluation (AGREE) instrument to evaluate validity (AGREE, 2001).

The National Kidney Foundation, KDOQI, guidelines presented a clear objective. The KDOQI guidelines were developed to improve outcomes for patients with CKD by providing strategies for health care providers related to the diagnosis, management, and clinical practice recommendations when treating patients with CKD. The development of the guideline involved numerous specialists including pharmacists, registered nurses, registered dieticians, and physicians. The recommendations were clear, concise, and easily identifiable. They were based on systematic reviews through January 1, 2001. When the guideline was based on published evidence they were labeled “Evidence”. When no definite evidence existed or the evidence was considered inconclusive, and either the guideline or steps were based on judgment, they were labeled “Opinion”. Furthermore the CPG was strengthened by reviews conducted by a broad-based panel of experts, organizations, and the public. There were few limitations of the guideline. There were not tools for application offered; cost was not discussed, and the potential barriers for implementation was not addressed (KDOQI, 2003).

The KIDGO guidelines focus on the management of CKD-MBD and are intended to assist the practitioner caring for adults and children with CKD stages 3-5, on chronic kidney dialysis, or with a kidney transplant. The guideline process followed an evidenced based

approach and treatment recommendations were based on systematic reviews of relevant treatment prediction. The recommendations were also linked directly with how this would be expected to achieve better outcomes for patients through better detection, evaluation, or treatment of disease. The guideline followed the GRADE approach for assessment for quality of evidence. Grade for strength of recommendations were either level 1 (strong) "We recommend…should", or level 2 (weak) "We suggest…might". Grade for quality of evidence was A=high, B=moderate, C=low, and D=very low.

Literature Related to EMR Use

Meta-analysis

Since no meta-analysis directly related to CKD and the use of electronic prompts had been published, a meta-analysis focusing on strategies that lead to increased likelihood of health promotion/disease prevention interventions was reviewed. Stone et al. (2002) evaluated the use of diverse approaches to promote preventative care activities such as adult immunizations and cancer screenings. The authors reviewed the literature using data bases: MEDLINE, the Cochrane Effective Practice and Organization of Care Review Group register, previous systematic reviews, and the Medicare Health Care Quality Improvement Project database. These were searched from 1966 through 1999. Selection criteria for relevant articles included controlled clinical trials assessing interventions to increase use of immunizations for influenza, pneumococcal pneumonia and cancer screenings such as those for colon, breast and cervical cancer in adults. Two independent reviewers extracted data characteristics such as reminders, feedback, education, financial incentive, legislative action, organization change, or mass media campaign.

The authors started with 552 abstracts and articles that were narrowed to 108 relevant studies. Of these, 95 were RTCs and 13 were controlled trials. From these chosen articles, they quantitatively assessed the relative differences of previously studied approaches focused on adherence to adult immunizations and screenings. Their findings concluded that organizational change followed by reminders, financial incentives, patient education, and feedback were the most successful approaches regarding adherence (adjusted odds ratio from 2.47-17.6; 1.82-3.42; 1.74-2.75; 1.29-1.53 & 1.10-1.76, respectively). They note that even though reminders were less effective than organizational change and financial incentives, this intervention consistently improved care (Stone et al., 2002). This analysis was strengthened by a large sample size of high level literature, independent reviewers, and the exploration of various means to improve adult immunizations and cancer screenings. A weakness that limited this study was the failure of the authors to consider the cost-effectiveness of the interventions.

Randomized Controlled Trials

Five RCTs were evaluated (Feldstein et al., 2006; Filippi et al., 2003; Lafata e al., 2007; Lester et al., 2005; & Sequist et al., 2005). Two of the five articles utilized blinding to strengthen their results. None of the articles posed a specific question but did clearly state objectives of the studies. The first RCT (Feldstein et al., 2006) assessed the effectiveness of whether patient-specific, clinical guideline information delivered to the provider by EMR, or electronic reminder to the provider plus an educational letter mailed to the patient would improve the care of osteoporosis for fractures. Participants were females aged 50-89 at a large non-profit HMO with 454,000 members. Chosen for the study were 311 patients who had suffered a fracture in 1999 and had not received bone mineral density (BMD) measurement or treatment with an osteoporosis medication. Additionally, 159 physicians participated in the study. Randomization

occurred at the patient level and blinded ascertainment of the outcomes was conducted. The women were randomly assigned to usual care (N=101), electronic reminder for guideline advice to the provider (N=101), or electronic reminder plus patient education letter (N=109). At six months, provider reminders resulted in 51.5% of patients receiving BMD measurement or osteoporosis medication. Provider reminder plus a patient education letter resulted in 43.1% of patients receiving this same BMD measurement or osteoporosis medication. This was compared to the usual care, and resulted in only 5.9% ($P < .001$) of the patients receiving this care. The effect of provider advice alone compared to provider advice plus patient education was not statistically significant ($p = .88$), (Feldstein et al., 2006). The trial was strengthened by randomization and blinding; however, limitations included: it was conducted at a single HMO facility with a fairly homogenous population; it may not be generalizable to other communities; there was a lack of variability in practice settings; and it used a small sample size and a short duration of the intervention.

Filippi et al. (2003) conducted a large RCT assessing the effects of using an EMR prompt to physicians in an attempt to get them to change their prescribing practices related to anti-platelet medications in high risk patients with diabetes. The participants were selected from a large Health Search Database which is owned by the Italian College of General Practitioners. This data base contains over 500 physicians and over 800,000 patients. Once all physicians received extensive software training, they were required to use specially designed software that would record data during their daily clinical practice. This software anonymously recorded demographic details, diagnoses, tests and test results, and drug therapy. The data was subject to weekly quality checks related to number of consultations, prescription completeness, prevention records, medical diagnosis, and mortality records. Data coming from physicians who failed to

meet standard quality criteria were not considered for the study. As a result, 300 physicians were chosen for participation. Among the participating physicians, 150 were randomly assigned to the intervention group while 150 physicians served as the control group. All physicians received a letter explaining the benefits of prescribing anti-platelet medication to high-risk diabetics. The intervention group also received instructions on how to activate the electronic reminder. The patients were selected based on a diagnosis of diabetes and at least one cardiovascular risk factor, which met the definition for high-risk diabetes. Ultimately, 15,343 high-risk diabetic patients were chosen based on concurrent disease such as cardiovascular disease or HTN. In addition, smoking status was examined and included as a risk factor in the high-risk diabetic patient. The final sample included 15,343 high-risk diabetic patients, with 7,313 (47.7%) belonging to physicians in the intervention group and 8,030 (52.3%) belonging to physicians in the control group. The results were observed to be a twofold increase in prescribing anti-platelet medications for high risk diabetic patients in the intervention group compared to the control group. Specifically, 1,672 (22.9%) of the patients in the control group at baseline were receiving anti-platelet medications compared to 1,886 (23.5%) in the intervention group. By the end of the study, the control group had 2,242 (30.7%) receiving anti-platelet medications compared to 3,012 (37.5%) in the intervention group. This represents totals across the two groups studied (Filippi et al., 2003). Strengths of this study include randomization of the physicians and the large sample size of physicians and patients. However, the study did have a short duration of six months, and this may not have given enough time for an adequate practice change to occur. Also, there is no mention of types or locations of practices so findings may not have been generalizable. Finally, there was no mention of how patients were randomized to the arms of the study.

In an effort to improve osteoporosis screening and treatment, Lafata et al. (2007) conducted a RCT using a usual care group, a group who received mailed reminders, and a group that received mailed reminders with physician prompts. The study patients were females between the ages of 65-89 years who were patients at a large multi-specialty group practice in Michigan. Inclusion criteria were patients with various types of insurance coverage and who did not have evidence of past BMD measurement or treatment. There were 123 physicians who participated from 15 suburban clinics and 10,354 eligible women. Fifteen primary care clinics were randomly assigned to one of three arms and stratified by size and on-site availability of BMD testing. Five primary care clinics comprised the usual care group and treated 2,901 women, five clinics treated 2,910 women in the mailed reminder arm, and five clinics treated 3,500 women in the mailed reminder plus physician prompt arm. The study was conducted over a 12 month period with the primary outcome of interest being the use of BMD testing. A secondary outcome was the dispensing of osteoporosis medication. The results showed significant improvement in the screening group that received a mailed reminder plus physician prompt. The usual care arm had a 10.8% rate compared to 21.4% in the mailed reminder arm and 28.9% in the mailed reminder plus physician prompt arm ($P< 0.001$). With respect to osteoporosis treatment, the rates for the usual care arm were 5.2% compared to 8.4% in the mailed reminder arm and 9.1% in the mailed reminder plus physician prompt arm, (Lafata et al., 2007). Strengths of this study include: a large sample size, randomized 3 arm trial, and the addition of patient education materials included in all mailings. Weaknesses include: only women who had insurance were eligible for the study, participants were exclusively from a suburban area limiting generalizability of results, the study was sponsored by Merck & Company, Inc., which manufactures osteoporosis medications, the

study did not consider characteristics of patients such as education, co-morbidities, functional status and income level, all which could contribute to the study outcomes.

In a RCT by Lester et al. (2005), the investigators assessed the use of an informatics-based intervention to increase statin prescriptions for the secondary prevention of coronary artery disease. The trial consisted of 14 physicians familiar with the access to EMRs and willing to consent to participate. All patients with CAD or risk equivalent above National Cholesterol Education Program recommended low-density lipoprotein (LDL) treatment goal for greater than six months were included in the study. In addition, patients who were over the age of 30 with coronary artery disease CAD or risk equivalent, and had been seen by the physician in the past 18 months with a documented LDL above 100mg/dL were also included. There were 235 patients who met the criteria. The patients were then randomly assigned to the usual care arm (N=117) or the intervention arm, provider prompt via an electronic email alert (N=118). The physicians were aware that they had an equal number of patients receiving usual care but blinded to the identity of these patients from the study's inception. The trial was conducted for 12 months and the results showed a significant change on statin prescriptions in the intervention group one month post-randomization (15.3% vs. 2%, P= <.001). Though not statistically significant for the overall study cohort, LDL levels were consistently lower in the intervention group (Lester et al., 2005). This trial was strengthened by randomization and physician blinding. Also the EMR prompting system was designed to give physician "one click" options when making changes to the patient's plan of care. The investigators were also able to track why patients did not receive treatment by evaluating the physician responses to a questionnaire, thus allowing the investigators the ability to evaluate the intervention to make future improvements. Weaknesses include small physician and patient sample size, and inability to track a "real" time

frame on completion of email prompt since this was based on time elapsed between emails and did not account for physician interruptions. Finally, it was unclear as to how the physicians were blinded to the usual care arm of the study.

Sequist and colleagues (2005) conducted a RCT of electronic clinical reminders to improve quality of care for patients with diabetes or CAD. They enrolled 194 primary care physicians in 20 primary care sites who were caring for 4549 patients with diabetes and 2199 patients with CAD. Randomization occurred at the site level and was based on site characteristics to balance the distribution. The 20 sites were randomized based on site characteristics to balance the distribution of gender and socioeconomic factors. Ten sites were in the intervention group and received an additional electronic reminder for diabetes and CAD, and 10 sites served as the control group and had no previous exposure to these disease specific reminders. The investigators then used four evidence-based guidelines to identify five recommendations for diabetes care and four recommendations for CAD care. The guidelines were the American Diabetes Association Standards of Medical Care for Patients with Diabetes Mellitus (2002); American College of Cardiology/American Heart Association (ACC/AHA) Task Force on Practice guidelines related to the management of patients with acute myocardial infarction (1999); the ACC/AHA guideline related to patients with chronic stable angina (2003); and the National Cholesterol Education Program on Detection, Evaluation and Treatment of High Blood Cholesterol in adults (2001). In the group of patients with diabetes over a six month period, reminders resulted in 19% in the intervention group vs. 14% in the control group receiving improved care. In the CAD group, there was a 22% increase in the intervention group vs. 17% in the control for recommendations of CAD care (Sequist et al., 2005). Strengths of this study include: clearly defined objectives, a large sample size of participants both patients and

physicians, randomization, clinical reminders based on evidence based guidelines, diverse study setting place and patients served, prompts built into the patient's main summary screen of the EMR, and finally short and concise reminders, usually less than 10 words. Weaknesses included: short duration of the study (six months), some of the outcomes that were measured relied on the physician to put this information into the health record, such as dilated eye exams, so it was uncertain if they had accurately entered this information, outcomes did not asses care received, software did not allow for direct computerized ordering by the physician, and there was not a method in place to track lack of physician acknowledgement of received reminders.

Additional Literature

The remainder of the studies were evaluated using Larrabee's (2009) Quantitative Literature Review Worksheet. A study by Larson, Ko, & Dominitz (2009) assessed the impact of an electronic reminder upon the timeliness and proportion of patients referred for evaluation of a positive fecal occult blood (FOB) test and the subsequent receipt of colonoscopy. This was a quasi-experimental, before-and-after study design that was conducted over two years. The authors did a retrospective comparison of patients from the prior year (N=634). They documented 468 patients with a positive FOB and prospectively entered this information into the EMR prompting providers to act upon the results. The intervention was associated with a 20.3% absolute increase in gastroenterology consultation within 14 days ($p < 0.0001$). The median time to colonoscopy decreased by 38 days during the intervention ($p <0.0001$), (Larson et al., 2009). This study was strengthened by the large number of participants, and the two year duration. A weakness of the study is that it took place at a Veterans Administration facility thus limiting the findings to the general population.

Another quasi-experimental study design using a pre-post test design was conducted by Goetz et al. (2008). These authors assessed whether a multi-component intervention increases the rate of HIV diagnostic testing. Five facilities were chosen with two receiving the intervention and three serving as the control sites. The intervention consisted of a real time electronic clinical reminder that encouraged HIV testing. Measurements were based on pre-to-post changes in the rates of HIV testing at the intervention and control facilities. The two intervention sites were able to demonstrate an increase from 4.8% to 10.8% and from 5.5% to 12.8% (both comparisons, $p < .001$). In addition there were 30 new diagnoses after the intervention vs. 15 pre-intervention. There were no changes observed with the control groups (Goetz et al., 2008). This study was strengthened by: the duration of the intervention of one year, familiarity of electronic prompts by providers in the Veterans Administration system, and the use of hand-outs, pocket-cards, and posters to provide additional structure and education to providers on ordering HIV testing for patients at risk. Weaknesses were noted as the lack of randomization of sites, and limited ability to generalize results to facilities outside the VA system and those settings that do not have EMR systems.

Fiks et al. (2007) assessed the impact of an electronic prompt in an EMR system designed to improve childhood immunizations. This was a one year intervention study that used historical controls. The study took place at four urban, primary care centers and involved 1669 patients in the intervention group and 1548 in the control group. During the intervention period, 15, 928 alerts appeared during both routine and sick visits. The alert implementation was associated with increases in captured immunization opportunities from 78.2% to 90.3% at well visits and from 11.3% to 32.0% at sick visits. Up-to-date immunization rates at 24 months of age increased from 81.7% to 90.1% from the control to intervention period. Children in the intervention group also

became up-to-date faster than the control patients (Fiks et al., 2007). This study was strengthened by the large number of patients involved and the one year duration. Also the electronic reminders appeared at the point of care, offered specific recommendations, and then facilitated compliance with recommendations. Weakness is noted as the potential for bias based on vaccine shortages in the control group.

Synthesis

The critical appraisal of two internally valid CPGs (KDOQI, 2003 & KDIGO, 2009) support the importance of early screening for MBD in patients with stage 3 CKD. Further support is offered by these CPGs for the treatment, screening, and management of these disorders. Evidence found by the critical appraisal of one meta-analysis (Stone et al., 2002), five RCTs (Feldstein et al., 2006; Filippi et al., 2003; Lafata et al., 2007; Lester et al., 2005; Sequist et al., 2005), two quasi-experimental studies (Larson et al., 2009; Goetz et al., 2008) and one interventional study (Fiks et al., 2007) supported the implementation of a prompt in an EMR system to improve management of chronic illness and increase health promotion. There were various interventions utilized related to physician reminders. Consistently the literature was able to demonstrate a positive benefit with respect to improved care and outcomes.

In a meta analysis conducted by Stone et al. (2002) the authors examined a diverse set of interventions used in the literature to improve adult immunizations and cancer screening. Some of the changes were slight, but overall improvement of care was noted with these interventions. They were not able to demonstrate that a provider reminder alone was consistent. However, they did see improvement with the adoption of a provider or patient reminder in conjunction with organizational change and suggest this should substantially increase the use of prompts.

Four of the RCTs (Feldstein et al., 2006; Lafata et al., 2007; Lester et al., 2005; Sequist et al., 2005) were able to consistently demonstrate improved outcomes with the use of EMR prompts. While Lester and colleagues (2005) and Sequist et al. (2005) just utilized EMR prompts, Lafata et al. (2007) and Feldstein et al. (2006) used an EMR prompt plus a patient mailed reminder. In each study, the patients were mailed an educational letter and then were randomly assigned to receive a physician prompt or not. Both studies demonstrated significant improvement compared to the usual care arm. Felstein et al. (2006) demonstrated that the provider prompt alone was most effective whereas Lafata et al. (2007) revealed a slight increase in the provider prompt plus educational letter to patient in the BMD screening arm, but no significant difference with this same arm in respect to treatment for osteoporosis. Filippi et al. (2003) were able to show a significant increase in the number of patients treated for CVD compared to the control group just by use of a physician prompt. However, they also noted that out of the 150 physicians in the intervention group only 128 actually activated the prompt in the EMR indicating the need for further research to understand the reasons why some physicians do not choose to utilize a prompting system.

The quasi-experimental articles by Goetz et al. (2008) and Larson et al. (2009) both demonstrated statistically significant improvements in care of patients with the use of physician prompts on the EMR, ($p < .001$ & $p < 0.0001$ respectively). However, Goetz et al. (2008) concluded that in addition to provider prompts, there needs to be provider feedback, activation, and social marketing to achieve highest outcomes. Finally, Fiks et al. (2007) were able to demonstrate improved captured opportunities for immunizations in a pediatric population related to a physician reminder prompt. However, there was a great potential for bias in this study since

there was a historical control group used and this did not allow for control of such things as vaccine shortages or overall immunization practice.

The literature demonstrates that provider prompts in various practice settings supports a positive impact on patient health outcomes. A capstone project was developed to screen at risk patients for stage 3 CKD using EMR provider prompts in a primary care clinic. In an effort to further support this project a theoretical framework was used to direct the change.

Theoretical Framework: Rogers' Diffusion of Innovation Theory

The Diffusion of Innovation Theory was used to guide this capstone project. The concept of diffusion of innovation has been in use since the early 1900s (Rogers, 1995a) and has a long history of use in the social sciences with roots beginning in Europe. Researchers at that time may have termed this theory by other titles but Rogers pointed out that they were actually describing diffusion concepts. Some of the areas of research interest were in: anthropology, sociology, psychology, agriculture, education, public health, communications, marketing, economics and health care. Based on his doctorate work related to the concept of diffusion at the University of Iowa in 1962, Rogers published the first chapter related to the concept titled the Diffusion of Innovations (Rogers, 1995b).

The Diffusion of Innovations Theory is based on a five step process (Rogers, 1995b) This process occurs over time among the members of the team or social system, and with time, the change will follow an S-shaped curve. Each person of the system faces his/her own innovation-decision that follows the following five steps (http://www.stanford.edu):

1) Knowledge. The person learns about the innovation and has some idea of how it functions.

2) Persuasion. The person forms a positive or negative attitude toward the innovation.
3) Decision. The person tests the acceptability of the innovation.
4) Implementation. The person puts an innovation into use.
5) Confirmation The person evaluates the results of an innovation-decision already made.

Rogers further describes the phases of the adopter categories of innovators: early adopters, early majority, late majority, and laggards are based on a member's decision making within the group (Rogers, 1995a). Innovators are noted to be venturesome, risky, and daring. They are usually involved with peer networking and social relationships and must be able to understand and apply complex technical knowledge to situations. Finally, they serve as gatekeepers for the flow of new ideas into a system.

Rogers (1995a) describes early adopters as being more integrated into the local social network and having the highest degree of opinion leadership. This individual is considered the person to check with before deciding on adoption of a new idea. They often serve as a role model for many others members and are generally respected in the group. They are known to place their stamp of approval on new ideas.

The second adopter that Rogers (1995a) describes is the early majority. This person usually adopts ideas a little sooner than the average member. They seldom hold positions of opinion leadership in the system. They are viewed as providing interconnectedness in the system's interpersonal network. Finally, they usually represent the majority of the members.

The late majority are usually skeptical and cautious (Rogers, 1995a). They often agree to new ideas related to peer pressure within the system. They are one of the last members to adopt a new idea, and likely will not do so until most of the uncertainty related to the idea is resolved.

The final adopter is the laggard (Rogers, 1995a). They are mostly isolated from the rest of the members and have traditional values. They are viewed as extremely cautious, and they are usually suspicious of innovations and change. The adoption of a change is often late in the process due to the lagging behind of the other members.

Berwick (2003) examined disseminating innovations in relation to Roger's theory of innovation. Berwick sought to identify why clinical care systems do not incorporate findings of best practices quickly and reliably into their daily practices. He discovered a cluster system related to dissemination of innovation that correlated with the rate of change. There were three clusters identified, the perception of the innovation, the characteristics of the people who adopt or fail to adopt the innovation, and the contextual factors involving communication, incentives, leadership, and management.

The first cluster is the perception of the innovation (Berwick, 2003) and is noted to be the most powerful. Individuals are more likely to adopt a change if they think it can help them. In this cluster, it is important to provide individuals with abundant knowledge regarding the innovation leading to what Rogers (1995a) calls "reduction in uncertainty", and then they are more likely to become adopters. Next, it is important that the innovation be compatible with the values, beliefs, past history, and current needs of the individual or practice. The change must resonate with currently felt needs and belief systems. A third factor is the complexity of the proposed innovation. In general, simple innovations spread faster than more complex ones. Berwick (2003) goes on to explain that if the innovation is slowing at this stage, then the change should be simplified. Finally, the innovation is more likely to be accepted in this cluster if one has trialability (the ability to do a trial of the innovation before doing a system wide change) and observability (the ease with which potential adopters can watch others try the change first).

The second cluster Berwick (2003) consists of individuals who may adopt the change, identified as the innovators. They are the fastest adopting group. They are usually distinguishable by their love for adventure, tolerance of risk, fascination with novelty, and willingness to learn. They are not seen as opinion leaders. The next group to be aware of when initiating a practice change, is the "early adopters". They are different from the innovators because they are opinion leaders. They are usually well connected within the system and interact with the innovators to share ideas. They are usually resourceful and risk trying new ideas. The next group is the "early majority", they are individuals who watch the early adopters. They are more reserved, learn mainly from people they know well and with whom they are personally familiar. This is more important to them than science or theory. These people are more interested in having their immediate needs met than in "interesting ideas". An even more conservative group is the "late majority". This group will look to the early majority for signals about what is safe to try. They will adopt an innovation when it is appears to be the status quo and not before. They watch for proof. The final group in this cluster is the "laggards". Rogers (1995a) terms these individuals as those for whom "the point of reference…is the past". Berwick (2003) points out that perhaps the term laggard is misstated in this group and suggests terms such as traditionalists, sea anchors, or archivists. These terms emphasize their ability to make decisions that are wise and useful to the organization.

The third and final cluster addresses the contextual factors and deals with managerial systems within an organization or social system. Some environments are nurturing of change often offering praise and incentives while others are discouraging, and often they view innovators as troublemakers. Organizations that foster social exchanges and are more nurturing

usually see the fastest acceptance of change (Berwick, 2003). Once the clusters have been identified, then the steps of the theory can begin.

There has been a great deal of research conducted using the Diffusions of Innovation theory in relation to change in the medical field. Hader et al. (2007) examined doctor's views of clinical practice guidelines (CPGs) using innovation theory. The authors interviewed 45 doctors from Saskatchewan in October of 1998. The doctors interviewed were from diverse geographic settings and consisted of general practitioners, general surgeons, and internists. The doctors said that they first needed to be made aware that a CPG existed. Once this had been identified, they noted several factors necessary to ensure adoption, implementation, and maintenance of the guideline. They needed to know that the CPG would address an area in which there was a perceived need for change. Next, they wanted to know that the guideline was based on sound scientific evidence that demonstrated improved outcomes. They wanted opinion leaders and respected colleague's support of the guideline, thus allowing them to perceive a change that was consistent with current trends in the field. Knowing that patients and families would support the changes as indicated by the guideline was also identified as important to these physicians. And finally, they wanted to know that there was the necessary technology, resources, and training available to implement the change.

Project

Background

Screening for vitamin D deficiency and iPTH levels in the primary care setting for CKD population is scant at best. *The Kidney Disease Outcomes Quality Initiative Clinical Practice Guidelines for Bone Mineral Metabolism and Disease in Chronic Kidney Disease* (K/DOQI,

2003) as well as the *The Kidney Disease: Improving Global Outcomes* (KDIGO, 2009) has set forth the recommendation that healthcare providers begin screening patients in stage 3 and 4 for 25-hyroxyvitamin D deficiency. Therefore, the KDIGO practice guideline related to CKD-MBD was introduced into a local primary care practice in Charleston, West Virginia for consideration.

Goal

The purpose of this capstone project was to implement a clinical practice guideline (CPG) related to CKD and vitamin D deficiency in a local primary care practice. Guided by the Diffusion of Innovations Theory, this project involved informational sessions with the stake holders (knowledge) to persuade adoption of a prompt in the current EMR system based on current guidelines. This prompt was intended to cue the provider to consider ordering lab work for patients with CKD stage 3 (persuasion). Once informational sessions were completed the stake holders would make decisions to accept the change (decision). The non adopters of the group would require additional support and education. The Stanford education website (http:www.standford.edu) estimates that once 10-25% of the system members have adopted the innovation, there will be a relatively rapid adoption by the other members. Implementation occurred when providers were ordering tests for patients with CKD related to vitamin D and iPTH. The confirmation stage of this theory was completed by a clinical site record review to determine effectiveness of the use of clinical reminders in the EMR system.

Theoretical Framework of the Project

Rogers' Diffusion of Innovation Theory served as a framework for the project. This theory encourages the use of opinion leaders to encourage guideline adoption (Moulding, Salagy, & Weller, 1999). The theory proposes that change is more likely to be accepted if the opinion leader is a respected peer. Rogers' (1995a) theory has been tested and tried in various practice

settings and industries. The mechanisms of diffusion allow for the change agent to flow between steps of the process and manage issues as they arise. This theory's most striking feature is that within a social system, when change is introduced, the decision to accept the innovation depends heavily on whether the other members of the system accept the innovation. Therefore, informational sessions about the project were conducted with the staff at a local primary care practice. The informational session consisted of a discussion with all staff regarding the CPG. In addition, a one page bulleted handout was distributed to the staff as a quick reference resource. These sessions also included familiarizing staff with the prompting system and templates. These various approaches were aimed at securing staff buy-in while also providing support and encouragement.

Setting

Living Well Medical Center (LWMC), PLLC, located in Charleston, West Virginia (WV) was the designated site for this capstone project. This privately owned clinic specializes in primary care of patients 15 years of age and older. Currently there are 6950 active patients. The practice is located in Kanawha County, West Virginia, the largest county in the state, with a population of 221.6 persons per square mile (U.S. Census 2007). There is a high prevalence of patients with HTN, DM, and dyslipidemia in the practice. Data from the practice indicates that 1452 patients are diagnosed with HTN, 476 with DM, and 1236 with dyslipidemia--three of the most prevalent causes of CKD (Greenway Medical Technologies, Inc., 2009). Record review was conducted based on these diagnoses. The data demonstrate a high number of patients that could potentially benefit from early screening and intervention related to MBD. Clinical experience indicated that patients were not being screened for these disorders in this CKD population. Additionally, the literature reviewed demonstrated that patients with chronic diseases

could benefit from better healthcare outcomes if screened early and appropriate interventions started. Nevertheless, there is no current screening program at this clinic to detect MBD in patients with stage 3 CKD.

Congruent with the mission and vision statement for LWMC, an intervention related to early screening of MBD in a CKD population met the expectations for this capstone. The mission of LWMC is as follows:

"Living Well Medical Center will strive to provide the highest quality of care to all patients regardless of race, color, sex, creed, disability, or cultural beliefs."
The vision of LWMC is as follows: "The vision of LWMC is to continue to offer the highest quality of care based on the latest evidence based medicine. Access to care is of utmost importance and we will continue to strive to afford patients this opportunity. Finally, our focus is on health promotion, disease prevention and improved quality of life." The proposal for this capstone project was congruent with the clinic's mission and vision goals. Screening patients who have stage 3 CKD for MBD employs the use of patient education related to MBD and underlying causes, health promotion, prevention, and early intervention.

Project Objectives

The implementation of a screening program for MBD in the CKD population in primary care was designed to detect early plasma changes in vitamin D, iPTH, calcium and phosphorus levels, precursors to MBD. Additionally, the intervention provided the clinic with a billable service to patients that could generate more revenue and help to sustain the intervention.

Projects of this kind need the foundation of written objectives to guide the process and ensure successful outcomes. SMART objectives were written for this project. SMART objectives refer to an acronym that is utilized to build projects based on five leading measures (March of

Dimes, 2004). The acronym can be used to write objectives and serves as a means to evaluate the quality of a proposed change. This acronym was used to develop the six objectives for this project and represents the following measure: Specific, Measurable, Action-oriented, Realistic, and Timed. Based on the purpose of this capstone project, it was expected that as a result:

1. Providers would voice verbal understanding of the EMR prompt after one informational session conducted by the project leader.
2. Providers would be able to state when to order screening lab work on stage 3 CKD patients after one informational session with the project leader.
3. Providers would be able to correctly identify and select appropriate patients to participate in the project by the end of the first week of implementation.
4. The project leader would be able to support the implementation of a prompt on the EMR by the end of the project using practice specific data.
5. The practice would develop a new policy to support the use of prompts on EMR for the screening of MBD in stage 3 CKD population by the end of the project.

Project Design

This evidence-based capstone project evaluated the effectiveness of a provider prompt on an EMR system related to the screening of BMD in patients with stage 3 CKD. This project was designed using evidence based guidelines and literature. According to the KDIGO (2009) guidelines set forth by the NKF, patients with stage 3 CKD should be screened for MBD. In stages 3-5 it is suggested by the guideline that vitamin D, iPTH, calcium, and phosphorous levels be assessed at initial diagnosis of CKD. This capstone project involved the use of an EMR prompt to remind the provider to screen patients with stage 3 CKD for hypovitamintosis D, and abnormal iPTH, phosphorous and calcium levels.

Resources

Available resources were identified prior to the implementation of the capstone project. The identification of these resources helped to ensure a successful project outcome. Resources for this project were identified as the key stakeholders, on-site laboratory service, established EMR, pharmaceutical educational literature, and a budget plan.

Stakeholders are persons, groups, or organizations that have direct or indirect stake in an organization. They can either effect or be effected by the organization's actions, objectives, and policies (Business Dictionary, http://www.businessdictionary.com/definition/stakeholder.html). Stakeholders for this project included internal persons who served as key site support and those external to the practice who would potentially benefit directly from the capstone project at LWMC. Key internal stakeholders were the owner and medical director of LWMC, a full-time nurse practitioner, and support staff including the office manager, the billing clerk, two medical assistants, one phlebotomist, and two front staff employees. The identified internal stakeholders offered full support for this capstone project at LWMC (see Appendix B for letter of support). External stakeholders were identified as patients and family that would be impacted by the implementation of the capstone project.

The use of an on-site laboratory was a strong resource for this capstone project. This project required serum laboratory testing related to stage 3 CKD. The one site laboratory offered convenience for the patient as well as the providers. The laboratory has one full-time dedicated phlebotomist and technical support via phone and email if needed to assist with laboratory data reports.

The EMR system at LWMC was established and offered local support staff for trouble shooting, obtaining data reports, and general support. The support staff within the clinic was

familiar with the system and therefore did not require training for the system as a whole. They only needed instruction related to the EMR prompt specific for MBD screening. This instruction was conducted by the investigator during an office meeting.

Educational literature was a valuable resource for this project. Pharmaceutical representatives donated free educational materials related to CKD and MBD . These materials were evaluated for health literacy as well as for lack of bias and accuracy of information. According to the World Health Organization's Healthy People 2010 goals, health literacy is defined as the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions (Center for Health Care Strategies, Inc. [CHCS] 2011). The National Assessment of Adult Literacy estimates that only 12% of adults have proficient health literacy which means that, approximately, nine out of ten adults may lack the skills necessary to manage their health and prevent disease. Low literacy has been linked to poor health outcomes such as higher rates of hospitalization and less frequent use of preventive services, both of which are associated with higher health care cost (CHCS, 2011).

Furthermore, health literacy is dependent upon communications skills and knowledge of the lay persons and professionals, culture, demands of the healthcare and public health system, and demands of the situation. For this project educational materials were assessed for grade level. It was determined that the grade level of these materials were at the sixth grade level.

Finally, a budget plan (see Appendix A for capstone project budget) was devised to guide this project. Fortunately, there was little to no financial cost related to this project. It was projected to cost approximately 30 dollars for laminated fact sheets to display in the exam rooms, this cost was covered by the project nurse practitioner leader. There was no added cost for

support staff time as the project was conducted during regular working hours. The cost of paper for data reports was covered in kind by LWMC. Space for the project was not a problem since the project was conducted during regular office hours for LWMC.

Timeline of Project Phases and Evaluation

In preparation for this project, it was necessary to identify tasks that would need to be completed. A project timeline helped with the timely progression of the project and prevented straying from the plan. The timeline for this project was separated into three phases.

Phase One

Phase one included a retrospective review of one hundred de-identified patient records. The sample was randomly selected using two selection criteria: diagnosis and date of encounter.

- The investigator obtained a de-identified, inclusive electronic list of all patients with the diagnosis of chronic kidney disease or any one of the three comorbidities that most likely attribute to the development of CKD: hypertension, diabetes mellitus, and hyperlipidemia for a one year period prior to initiation of provider prompts.
- The de-identified patient list was numbered consecutively and a sample of one hundred records were identified using a table of random numbers.
- The investigator reviewed each of the randomly selected records to determine if patients were screened for mineral bone disorders (MBD).

Phase Two

Phase two involved a twelve-week implementation of an electronic medical record prompt for all patients with any of the diagnoses listed above.

- The investigator was previously in contact with the EMR software company to develop an electronic system to prompt providers to order iPTH, vitamin D 25-OH, calcium and phosphorous levels for patients with an estimated glomerular filtration rate (eGFR) < 60 ml.min/1.73^2 (diagnostic of stage 3 CKD). Abnormal laboratory values for iPTH, vitamin D 25-OH, calcium and phosphorous are used to determine MBD in patients with stage 3 CKD.
- The investigator conducted an orientation to the electronic prompt, which include prevalence of MBD in the CKD population, and the health implications of these disorders.

Phase Three

Phase three involved evaluation of the newly initiated electronic prompt.

- The investigator obtained an inclusive, de-identified electronic list of all patients with the diagnosis of chronic kidney disease or any one of the three co-morbidities that most likely attribute to the development of CKD: hypertension, diabetes mellitus, and hyperlipidemia for the twelve week implementation period.
- The investigator reviewed a sample of 100 records to determine if patients were screened MBDs.
- The investigator compared the percentage of patients screened for MBDs in the initial random record selection to the percentage of patients screened for MBDs during the twelve-week implementation period of the EMR prompt.

The project implemented at LWMC was grounded in the literature which supports the early screening of patients with stage 3 CKD for MBD. Record reviews monitored the effectiveness of

the project change. Final results were given to the owner of the practice as well as the investigator's committee members.

Evaluation

The evaluation phase of the project began after the twelve week implementation phase. A random selection of one hundred patient records for a one-year time frame prior to the intervention (October 1, 2009 thru October 31, 2010) were compared to a second set of one hundred randomly selected records for the twelve-week intervention period (November 3, 2010 thru February 3, 2011). Data collected included the pattern of orders for laboratory studies to screen patients for MBD; and the presence or absence of the correct diagnoses of stage 3 CKD in the patients' records. For each record, 16 variables were reviewed. The variables included: screening for MBD, vitamin D level, calcium, phosphorus, iPTH level, stage of eGFR, diagnosis of stage 3 CKD, diagnosis of stage 3 CKD in the record, ICD-9 codes; 250.00, 250.01, 250.02, 272.4, 401.0, 401.9, 585.3, (see Appendix C for data key). The statistical software used for the data analysis was SPSS 18.

After data collection was completed, the project objectives were evaluated. The first two objectives were: *Providers will voice verbal understanding of the EMR prompt after one informational session conducted by the project leader; and providers will be able to state when to order screening lab work on stage 3 CKD patients after on informational session with the project leader.* These two objectives were met. A one-time informational session was conducted on November 2, 2010. This session included a PowerPoint presentation and review of the educational materials. Those present for the session included the physician and nurse practitioner as well as two medical students. All providers voiced understanding of the proposed project.

The third objective met was: *Providers will be able to correctly identify and select appropriate patients to participate in the project by the end of the first week of implementation.* To address this objective, a one-week follow-up meeting was conducted on November 10, 2010. Providers voiced understanding of the process of correctly identifying patients for screening after one week of working with the EMR prompt. They correctly demonstrated how to review previous lab work to identify the patients with stage 3 CKD and correctly identified the laboratory screening tests appropriate for identified patients.

The fourth objective for this project focused on adoption of an on-going prompt on the EMR system to screen at risk patients for MBD. Specifically this objective was: *The project leader will be able to support the implementation of a prompt on the EMR by the end of the project using practice specific data.* As illustrated in the results section below, data from this project demonstrated a lack of screening patients for MBD and omitted diagnosis of patients with stage 3 CKD, even after the electronic prompt was initiated.

Finally, the fifth objective to be addressed was: *The practice will develop a new policy to support the use of prompts on EMR for the screening of MBD in stage 3 CKD population by the end of the project.* The practice has agreed to continue working with the prompt with the additional support of the Litholink laboratory system. A decision to make a policy change will be determined at a later date by the practice owner.

Project Results

The purpose of this project was to determine if the use of a prompt on the EMR system would improve the screening of patients with stage 3 CKD for MBD in a primary care setting. Current guidelines support the screening of patients with stage 3 CKD for MBD. The early

recognition and treatment of this disease in this population can improve health outcomes and quality of life.

The initial plan was to review a random selection of records prior to the project, implement the electronic prompts for a period of time, evaluate a random selection of records of patients seen during the implementation period, and compare the data to evaluate the effectiveness of the project. Patients were chosen based on the existing diagnoses of HTN, DM, or hyperlipidemia, three of the most common causes of CKD. Therefore, to guide this evaluation process, two questions were posed: 1) Was there a statistically significant difference between the two groups with respect to ordering screening laboratory studies for MBD; and 2) Was there a statistically significant difference between the two groups with respect to appropriately diagnosing patients with stage 3 CKD? However, during the early stages of the data collection, the investigator noticed an unexpected variable with strong potential to affect whether or not MBD screening tests were ordered. It was noted that many patients who met the diagnostic criteria for stage 3 CKD were not diagnosed. This was an unexpected finding, but important to explore, as it was logical that the providers at LWMC would not have known to order screening tests for this population if the patient was not appropriately diagnosed.

The data was examined to see if there was statistically significant difference for the two groups related to screening for MBD. A Fisher's Exact Test of independence was calculated comparing the results of screening between the pre-intervention group and the post-intervention group. No significant difference was found ($p = .669$) in the two groups for screening. The data revealed in the pre-intervention group (N=99) 26 patients with an eGFR between 30-59 $ml.min/1.73^2$, had stage 3 CKD. It was determined that these patients were eligible for screening.

In the post-intervention group (n=99) 27 patients had an eGFR between 30-59 ml.min/1.73^2 and therefore should have been considered for screening.

Screening for MBD involves evaluation of vitamin D, calcium, phosphorus and iPTH levels. The groups were compared by looking at each of the four screening labs. Data revealed that 3/26 patients were screened in the pre-intervention group for Vitamin D level, versus 2/27 in the post-intervention group. This did not represent a statistically significant difference (p = .669). No statistical analysis was performed for calcium levels since all patients in both pre and post intervention groups were screened.

Additionally, phosphorous levels were examined; no difference was noted for the ordering of these levels. One out of 26 patients were screened in the pre-intervention group versus 1/27 in the post-intervention group (p=1.00). The same findings occurred for iPTH levels. Three out of 26 patients were screened in the pre-intervention group versus 5/27 in the post-intervention group (p=.704). Overall, there was not a statistically significant improvement in the ordering of screening labs for MBD when the groups were compared.

The second question that was analyzed examined if there was a statistically significant difference between the two groups with respect to the presence on the record of the correct diagnosis of stage 3 CKD. Once again, Fishers Exact Test was calculated comparing the two groups. No significant difference was found (p = .491). In the pre-intervention group 0/26 patients were correctly diagnosed; in the post-intervention group only 2/27 were correctly diagnosed.

The findings from this project did not demonstrate statistical significance.
In contrast to the literature discussed in previous pages, this project data indicated that the use of provider prompts alone were not enough to change provider behavior. This emphasizes the need

for continued research in the area of EMR prompts and their effects on patient outcomes and providers attitudes toward change.

Discussion

There were several interesting and unexpected findings related to the project at LWMC. These findings ranged from specific practice findings to community opportunities. These emerging community opportunities could affect population health outcomes related to CKD in West Virginia.

To begin, the data revealed a problem of undiagnosed patients with stage 3 CKD. This information was shared with the clinic providers. These findings were significant as they can serve to improve the diagnosing and appropriate treatment of patients with stage 3 CKD. In a study conducted by Rothberg et al. (2008) the authors examined the rate of recognition and appropriate management of patients with CKD in ambulatory settings. They reviewed 814 patient charts of patients aged 65 and older at two clinic settings. They found 33% of these patients had stage 3 CKD and 5% had stage 4 CKD. Of these patients, providers identified 38% of those with stage 3 CKD s, and 87% of those with stage 4 CKD . However, less than half of all cases were identified by the providers. When a patient was appropriately diagnosed they were more likely to receive proper medications, referral to nephrology, urine testing and less likely to received contraindicated medications. They concluded that primary care providers frequently fail to diagnose CKD, which in turn leads to inappropriate treatment and intervention. With proper diagnosing, appropriate intervention and treatment are more likely to occur in this population. Finally, utilizing a successful method to improve the rate of accurate diagnosis of CKD in the clinic site for this capstone project could n in turn serve as a model for other primary care practices.

As noted earlier, the project site at LWMC, had an on-site laboratory operated by a national company. When reviewing project outcomes with the providers they stated that they did not have a clear understanding related to insurance coverage for specialized lab testing (iPTH and phosphorus levels). Therefore, the providers were hesitant to order these specialized tests for fear of creating a financial burden for the patient. Upon further investigation by the project leader it was discovered that the practice had access to a software program called Litholink CKD. This program could interface with the clinic's EMR. This is a comprehensive electronic program for CKD and was based on the KDOQI guidelines. It is available to providers to assist in the early recognition, diagnosing, treatment, and referral processes for patients with CKD. Once the provider has enrolled the patient in the program quarterly trending reports will be generated and sent to the provider via a PDF format that can easily be uploaded into the patients EMR. These reports target trending patterns in MBD, lipids, and anemia which would greatly help busy primary care providers. The program identifies payor sources, and assesses for appropriate diagnosing when the patient is enrolled. The program is further simplified for the provider by offer a single billing code that is ordered by the provider. This billing code will cover the appropriate screening laboratory studies. Although this program was not available during the project period, it does serve as a positive unintended consequence that could help to further the efforts that were started at LWMC.

Project Outcomes

The outcomes of this project serve to support future work and community involvement in the area of CKD. Local and statewide opportunities have emerged as a result of this project. Additionally, this project has led to the discovery of important clinic specific information that can be used to improve health outcomes for patients with stage 3 CKD. Lastly, findings related

to diagnosing patients appropriately can serve to guide development of ways to improve diagnosis, intervention, and treatment strategies for this population.

The West Virginia Department of Health and Human Resources (WVDHHR) Division of Health Promotion and Chronic Disease Prevention focuses on reducing the prevalence of chronic disease and their contributing risk factors through health promotion. The members of this division have been in contact with the project leader and have requested a follow-up meeting after completion. They voiced interest in the findings of the project outcomes with the potential to use these results to develop strategies that support CKD diagnosis and screening in outlying rural clinics in West Virginia. A large focus of this division is developing appropriate interventions and strategies that can be integrated into community based health services throughout the state. They work to develop partnerships, organize data, developing strategic plans and implement evidence-based interventions in West Virginia healthcare systems. Their interests with this project are twofold; first, learning the challenges and benefits of working with EMR in primary care settings; and second, to collect data specific to CKD in West Virginia and in turn formulate a report for health care providers. They are interested in utilizing EMR systems in these efforts.

In addition to working with WV DHHR, there is opportunity to collaborate with a nephrologist for West Virginia University. This provider is a strong advocate for CKD education in the state. In an effort to improve education, early recognition, and intervention for patients with CKD, the task of revamping current educational materials is underway. These materials are geared toward primary care providers in West Virginia. The project leader would be a volunteer on this committee and serve where the need is greatest.

Intervening Factors

Concurrent factors may have contributed to the outcomes of this project. Other initiatives that were occurring at the site may have utilized the needed resources for this project, such as provider time, and could account for the lack of statistically significant results. These concurrent initiatives within the practice were not anticipated. As with any busy medical practice, time is a valuable and limited commodity and anything that takes more time per patient may be difficult to implement. The practice recently started a medical weight loss program that involved the time of several staff members. Also, the practice has a growing cosmetic division that also requires the attention of devoted staff. In addition, a concurrent smoking cessation program was initiated on the day the project was started. This program along with the initiation of a new EMR prompt could serve to overwhelm providers and therefore cause confusion and frustration. Additionally, the smoking cessation program offered a billing code that providers could use that would in turn generate revenue for education and teaching, whereas the EMR prompt for screening did not.

Another factor that was not accounted for was the presence of existing calcium levels on all patients. Since all patients reviewed were seen by providers on regular intervals of three and six months, a basic metabolic panel, or comprehensive metabolic panel had previously been obtained. Both of these panels include a calcium level, therefore this variable could not be considered for statistical analysis since 100% of those records reviewed had calcium levels.

The final unanticipated factor that likely had the biggest impact on the project was the presence of a series of medical and nursing students rotating through the practice. Students rotate through the practice on four week intervals with an average of two students for each rotation. The intended plan was that the providers would orient the students to all prompts on the system. During a post-intervention debriefing session with the providers, it was determined that this was

not carried out. Providers indicated that they did not offer the orientation to students due to lack of time and the high volume of patients. Additionally, it was revealed that the students often had the first contact with the patient record when completing the patient's history and physical. The prompt for this project was on the initial screen. If the student chose to move past the prompt then it would not be available when the provider came in contact with the patient record.

The clinic owner believed it was imperative to train the students on more acute prompts that existed in the system. Examples given were prompts that addressed prostate serum antigen levels, mammography and colonoscopies. These prompts were easier to address as they only required a "yes/no" response. However, it should also be noted that the students failed to question the providers about the prompt specific to this project. This generated questions related to extent of education students are receiving in their curriculums that address technology and EMR systems. Finally, the project leader was not available on site in a full-time capacity to orient the students to the specific prompt and goals of the project. This was identified as a potential barrier to the success of the project.

Theoretical Framework

The Diffusion of Innovation Theory was used to guide this capstone project. The Diffusion of Innovations Theory is based on a five step process (Rogers, 1995b). The process occurs over time among the members of the team or social system, and with time, the change will follow an S-shaped curve. The theory's success depends on the individual recipients' response or "buy-in" to the proposed change. In a retrospective review of the project at LWMC, the investigator was able to identify areas of weakness with this framework as it related to the project. Even though the providers had the knowledge to move forward with the project, as they progressed they formed a negative attitude toward the change. This reportedly occurred because

they often felt overwhelmed with the demands of the day-to-day obligations of the practice. Without the presence of the project leader on site, they did not have a gatekeeper to assist with the flow of questions or new ideas into the system. This in turn contributed to the lack of acceptance to the prompt. The project leader believes that this theory was an appropriate choice for this project. Moving forward it will be important for the project leader to be more involved with peer networking and relationships within the practice and to serve as a champion for the change. With this support, there is a higher likelihood of provider adoption of change and a successful practice change.

Implications

Further Practice Implications

Although the project did not result in a statistically significant improvement in the screening of patients for MBD with stage 3 CKD, this was the first project of its kind at LWMC and served to bring awareness of this issue to the providers. This project was grounded in the literature and congruent with the vision of LWMC "to continue to offer the highest quality of care based on the latest evidenced based medicine….our focus is on health promotion, disease prevention and improved quality of life". The project was the first step in the process of changing provider behaviors to include adherence to recommendations set forth in the guidelines for the diagnosis and treatment of MBD. This project has served to develop a relationship with WVDHHR Division of Health Promotion and Chronic Disease Prevention. The findings from this project will be shared with this division in the hopes of implementing similar practice changes in healthcare facilities throughout the state that include attention to challenges and barriers identified in this project.

Further work will need to be done in conjunction with the providers at LWMC to fully achieve the objectives. Part of this work would be the identification of a clinic champion to serve as guide for the project. Additionally, regular involvement with staff and students by the project leader would help to improve communication, serve as a reminder to staff and providers and educate students rotating through the practice. This physical presence of the project leader would also provide an opportunity to trouble-shoot issues or questions that providers may have. The availability of the in office Litholink laboratory software would also help to support the project and provide both patients and providers with quarterly reports based on renal specific lab values. Finally, potential barriers to the success of the project were identified and discussed with the providers. This knowledge can be addressed moving forward to avoid similar obstacles to the success of the project.

Implications for DNP Practice

The care of patients with CKD is complex and often labor intensive. This patient population requires continual assessment, planning, intervention and patient education. This continuum may last days or decades. Advanced practice nurses can play a valuable role in caring for patients with chronic diseases and their multiple co-morbidities because of their ability to address the multidimensional nature of chronic problems (Boville et al., 2007). Out of a growing concern related to quality of patient care and delivery of outcomes, The American College of Nursing (AACN, 2006) released a position statement focusing on the role of advanced practice nursing. This report entitled, *The Essentials of Doctoral Education for Advanced Nursing Practice,* is designed to prepare nurses for the highest level of leadership in practice and scientific inquiry, the doctorate of nursing practice (DNP). Nursing as a practice profession requires both practice experts and nurse scientists to expand the scientific basis for patient care.

Nurses prepared as DNPs are experts in specialized advanced practice nursing roles. They focus heavily on practice that is innovative and evidence-based, while reflecting the application of research findings. They are prepared for expertise in practice related to interdisciplinary to interdisciplinary settings, information systems, quality improvement, patient safety, leadership, evidence-based practice, healthcare policy as well as clinical prevention and population health for improving patient health outcomes.

This project change addressed several areas specific to the role of the DNP. Scholarship and research are the hallmarks of doctoral education (AACN, 2006). The application and translation of research into practice is a fundamental role of the DNP. The project at LWMC was supported by evidenced based literature and CPGs. Once the project concluded it was imperative that the findings be disseminated to allow for integration of new knowledge that would ultimately lead to improved patient outcomes. Even though the findings from this project were not statistically significant, this knowledge alone provided the catalyst for change within the practice that will focus on improving patient safety and care. In addition, identification of potential obstacles and challenges to implementing a practice change such as this in a busy primary care practice enables those involved to consider revising the strategy to support a better outcome.

In addition to scholarship and research, knowledge and skills related to information systems and technology within the healthcare setting are needed to improve patient care and outcomes. The DNP prepared nurse can be distinguished by their abilities to use information systems and technology to improve patient care in the healthcare system. This knowledge can provide support to leadership roles both in the healthcare and academic settings. The purpose of this project was to evaluate the effectiveness of a provider prompt on the EMR system to assist

in screening patients with stage 3 CKD for MBDs. The data from this technology can provide a mechanism for the DNP to aide in decision support, the use of disease specific tools, and specific practice information to improve patient care. The results of this project have led to the support of additional software that will be integrated into the current EMR thus allowing providers a more time efficient method of identifying and managing patients with CKD. This demonstrates the ability of the DNP prepared nurse to not only identify practice problems and patient care issues, but to also reflect on the application of research as it applies to these issues. Finally, this project demonstrated the need for the expertise of the DNP prepared nurse to become involved with technology as it relates to improving patient health care outcomes and the dissemination of this knowledge into practice.

The DNP has a foundation based in disease prevention and population health (AACN, 2006). Population health is defined by Allan et al. (2004) to include aggregate, community, environmental, occupational, and socioeconomic facets of health. Aggregates are groups of individuals defined by a shared characteristic; in the case of this project, the aggregates were adults with the diagnosis of stage 3 CKD. This group was selected due to the many complications of CKD that occur long before renal replacement therapy is ever needed. These risks include: MBD, anemia, secondary hyperparathyroidism, and nutritional deficits, just to name a few. These complications contribute significantly to the morbidity and mortality of this population (Lenz and Fornoni, 2006).

This focus of disease prevention and population health activities is also central to achieving the national goal of improving the health status of the population of the United States. There is currently a national call for healthcare providers to meet these needs and they are outlined in Healthy People 2020, (United States Department of Health and Human Services,

2011). This report has specific goals that address CKD. The goal for 2020 is to reduce the new cases of CKD and its complications, disabilities, death and economic costs. The project conducted at LWMC was lead by a DNP student with the overall goal of screening patients in primary care with CKD for MBD in an effort to begin early intervention and treatment and improve outcomes for this fragile population. With early diagnosing, education and treatment the complications from this disease and its many co-morbities could be drastically improved.

The project at LWMC was the first project of its kind. This project has served as a foundation for practice change. The data from the project outcomes is being used as a means to improve practice in various areas: appropriate diagnosing of patients with CKD which will lead to appropriate and safe treatments for this population as well as timely referral to nephrology; improving education strategies for providers and students related to CKD; improving EMR prompts to make them more practice specific with the integration of support software; and ultimately practice specific data that will lead to improved health outcomes for this population with a successful practice change.

Implications for Future Research

Mineral bone disorders in CKD are common and continue to be under diagnosed especially in the primary care setting (Bhan, Dubey, Myles, and Wolf, 2010). This capstone project demonstrated the need for continued research to examine provider behaviors related to adopting change. This is not to offer criticism of the care patients receive at exceptionally busy primary care offices, but rather to explore the obstacles to change that exist.

Nursing is now in an era where patient records are being computerized and documentation is being conducted via a multitude of technologies. Nurses' history with EMR systems differ from that of physician providers (Robles, 2009). Many nurses have been involved

with implementing EMRs and sometimes in the design of software, but the decision to change from paper to electronic documentation was often not a choice.

Most of the research related to EMRs and nursing care has been conducted in acute care hospitals, nursing homes, or psychiatric settings. It is therefore difficult to say whether these findings could be extrapolated to the outpatient primary care setting. Garrett and Klein (2008) found that advanced practice nurses in the hospital setting were receptive to the use of wireless hand held personal devices. However, they limited their use of these devices to reference tools such as drug or laboratory reference and diagnostic/laboratory applications. They also believed that the wireless connections facilitated improved access to sources of expertise and technical information and permitted greater mobility with their practice. They did not address actual use of these devices with respect to patient documentation or education.

Another area of research focus is the area of technological development. This field is highly competitive and rapidly growing. Further research should to be conducted that would focus on the roles of advanced practice nurses in terms of out-patient primary care clinics and the risks and benefits of EMRs. Additionally, research should focus on EMR usage as it relates to patient outcome evaluations, assessments regarding capabilities of EMRs to interface with local hospitals and laboratory data banks, cost effectiveness of these systems, patient safety, and quality of life.

As previously discussed, the data from this project revealed a significant lack of proper diagnosing of patients with CKD. Further research needs to be conducted to focus on why providers are not appropriately diagnosing and treating one of the main complications of CKD. Bhan et al. (2010) conducted a retrospective cohort study using EMR of 69,215 patients in a large academic setting. The study focused on the diagnosis and management of MBD in early

CKD in the primary care setting. Chronic kidney disease was found in 12% of the population. Fewer than half of these patients underwent testing for iPTH or vitamin D levels. Among those that were tested, vitamin D deficiencies and secondary hyperparathyroidism were present in 65% and 55% respectively. The results of the study suggested that CKD and MBD are under-diagnosed and under-treated, which could result in increased cost and decreased quality of care for this population.

Though on a smaller scale, the outcomes of the 12 week project at LWMC had similar findings which demonstrated under-diagnosing of CKD and MBD. In the pre-intervention group 26.3% of patients were determined by further record reviews to have stage 3 CKD, but were either mis-diagnosed or had a diagnosis missing. This was compared to 25.3% patients in the post-intervention group. With respect to ordering of vitamin D levels and iPTH levels; in the pre-intervention group only 11.5% of the patients underwent testing. In the post-intervention group; only 7.4% and 18.5% respectively were screened using these laboratory values.

Additionally, future research should focus on the effective use of EMR systems in busy practices. The providers at LWMC expressed concerns with lack of time to respond to the prompt on the system and viewed the prompt as a time burden. Therefore, research should focus on how to design software that is user friendly and efficient. Furthermore, research efforts need to explore efficient ways of integrating this technology into practice reality. In a cross-sectional study conducted by Crosson et al. (2007) the authors analyzed 50 out-patient practices participating in a practice improvement study between April 2003 and December 2004. Chart audits were conducted on 20 random number of medical records from patients with diabetes to assess for adherence to guidelines for diabetes processes of care, treatment, and achievement of intermediate outcomes. Thirteen of the 50 practices were using EMRs. Diabetes care in all

practices showed room for improvement. However, after adjustments, the practices that did not use EMRs demonstrated greater compliance with guidelines related to intermediate outcomes. The authors speculate that these differences could be attributed to the variance in commercially developed EMRs and the availability of technological support for the practice. Additionally, they noted implementation of EMRs in busy practice settings without sufficient attention to work flow redesign can create new quality problems and adversely affect patient outcomes. Finally, they recommend that EMRs include, or make more easily usable features that can support improved health care quality, such as developing chronic illness registries capable of identifying patients for whom treatment intensity is warranted.

With the project at LWMC, the inability of the EMR to create a trending lab for the eGFR prompt was identified as a barrier to the success of the project. A user friendly feature that would allow providers to trend laboratory values, vital signs, and medication histories without having to navigate through multiple pages would potentially improve patient outcomes for patients. Additionally, as a result of the outcomes of this project it was determined that research should be conducted on systems issues as they relate to change. The providers at LWMC did not accept the change of the prompt during the 12 week implementation phase. Exploring why providers elect to follow or abandon a prompt in an outpatient setting would help bring awareness to these issues and allow for improved success of other such projects.

Implications for Education

In review of the project findings, one of the variables that may have affected the results was the presence of students in the practice. This may indicate that educational programs need more emphasis on health information technology. Examining curricula both in medical and nursing schools related to EMRs and other technology is important. Students may feel

unprepared to navigate EMRs or perhaps have limited exposure to technology as a whole as it relates to the healthcare system. Regardless of the reason the conclusion from this project was consistent with the research, which demonstrates a lack of education related to health information technology in both medical and nursing curriculums.

The use of EMRs in primary care offices is becoming more prevalent especially since the passage of the America Recovery and Revinvestment Act (ARRA) in 2009. This bill was designed to provide funding to promote healthcare reform through the use of health information technology. Nineteen billion dollars was earmarked to drive reform through the use of health information technology and the adoption of EMRs. The clinic at LWMC has been using an EMR system since 2003. However, despite the computer skill of the practice owner and other providers, the medical and nursing students lacked the proper training and education to effectively work within the system. As this project demonstrated, the most significant finding was the failure of students to follow or question the appearance of the prompt for eGFR on the system.

Stead, Searle, Fessler, Smith and Shortliffe (2010) propose that given the central role of health information technology in clinical practices, student providers should be taught from the preclinical years through graduation and beyond the dynamics of health information technology and EMR. Chen, Safdar and Nagy (2011) examined the findings of a 2006 survey conducted by Briscoe et al. (2006) that explored the attitudes of medical students regarding the need for proper informatics training. The survey found that 81% of medical students and residents agreed that technology skills should be taught in their medical curriculum. Additionally, 92% believed that this technology should be taught in medical school. The final recommendation from the survey was to add formal technology training to medical curriculum.

Similar to medical school curricula, literature supports the need for more robust strategies aimed at health information technology in nursing curricula. A study conducted by Ornes and Gassert (2007) examined the computer competencies in a baccalaureate curriculum They discovered that no syllabi for the courses included informatics knowledge competencies therefore students received limited informatics exposure and were potentially ill prepared to use information technology. Furthermore, the authors addressed the implications for nursing education. These include: increasing faculty knowledge and understanding of nursing informatics, the addition of informatics curriculum, and skills laboratories to allow students and faculty to train on EMR systems.

Likewise, Candela and Bowles (2008) examined the perceptions of recent nurse graduates towards their education preparation. They conducted a descriptive survey for the study. The survey was mailed to 3,077 nurses in Nevada. A total of 352 nurses (12%) returned the survey. The average nurse was female, younger than 35 and generally worked full time in 12-hour shifts. One third of the respondents worked in medical-surgical areas. More than half of the respondents left their first job within the first two years. The survey focused on three core areas related to nursing education preparedness: skills for practice, professional development, and clinical performance. Various areas of weakness were noted from the data. Fifty-one percent of the respondents felt ill prepared with respect to pharmacology skills, 77% believed they could have used more clinical practice hours and 77% felt least prepared in the areas of management, leadership, and organizational skills which included accessing and managing electronic patient data systems. This finding is disturbing as this is the kind of charting that is quickly become a standard across the country in healthcare settings.

While it is not necessary that students become computer programmers or be responsible for designing systems, they do need to learn the importance of health information technology in clinical practice. They need to be aware of the potential impact of EMRs from more than a billing perspective. Rather, they need to be informed practitioners who understand both the strength and weaknesses of the tools they will be using in their practices. Finally, in an effort to improve outcomes for this population, this project points to a need for students to learn early recognition and identification of CKD. The project at LWMC revealed that patients were not being correctly diagnosed with CKD. In the process of the record reviews it was noted that patients were often given diagnosis of renal insufficiency or acute renal failure when laboratory values clearly indicated CKD. The care of patients with renal insufficiency or acute renal failure versus CKD is vastly different. Therefore, without a correct diagnosis appropriate care cannot be given, thus potentially leading to poorer outcomes. Very little published research in this area focuses on nurses. However, the need to properly diagnose CKD is supported by extant research focusing on medical students and physicians.

Because of the large number of patients with CKD and the relative small number of nephrologists, most patients are likely to receive their CKD care and pre-ESRD management from primary care providers. Agrawal, Barnes, Ghosh, and McCullough (2009) surveyed medical residents to see if current residency training adequately prepares a future internist in the management of CKD. They determined that knowledge of CKD management improved as they progressed through their programs, however awareness and adherence to CKD guidelines was low across all years of program study.

Clinical practice guidelines for CKD have been developed to assist providers in the early detection and treatment of patients with CKD. Non-nephrology providers need to be aware of the

complications, screening methods and treatment goals for this population. In 2006 Lenz and Fornoni conducted a web-based survey to assess perceptions and practice patterns in CKD care among 376 family medicine and internal medicine trainees in the United States. The focus was on the identification of CKD risk factors, screening for CKD and associated co-morbidities, as well as management of anemia and secondary hyperparathyroidism. Their data revealed that CKD risk factors were not universally recognized and screening for co-morbid conditions were generally not taken into consideration. The results of these surveys coupled with the findings of the capstone project at LWMC support the need for improved educational efforts to raise awareness of CPGs and recommendations for patients with CKD with future practitioners.

Summary

Chronic kidney disease remains a common, yet grossly under-diagnosed, disease that leads to increased morbidity and mortality. In an effort to improve the recognition and early treatment of patients with CKD, the NKF (2002) published evidence-based guidelines on recognizing and treating CKD: *National Kidney Disease Outcomes Quality Outcomes Quality Initiative.* In 2009 the NKF developed a second set of guidelines related to the care of patients with CKD. These guidelines are specific to the wide variation of complications this population faces: *Kidney Disease: Improving Global Outcomes* (KDIGO). One of the complications this population faces is MBD. The KDIGO guideline specifically addresses MBD, particularly the early recognition, intervention and treatment of the disease. Evidenced based literature supported the project conducted at LWMC for the screening of patients at risk for CKD for early signs of MBD.

Although the project did not result in a statistically significant improvement in the screening of patients for MBD with stage 3 CKD, this was the first project of its kind at LWMC and served to bring awareness of this issue to the providers. Findings from this project indicated that an EMR prompt alone was not sufficient to change provider behavior. This finding supports the need for further research and education related to EMR, prompts, and other ways to influence provider behaviors. Overall, these findings have helped to illuminate problems related to implementing change in a busy primary care practice that should be addressed in the future.

Screening patients at risk for complications related to CKD is scant at best. With the use of technology, such as provider prompts on the EMR systems, patients with early stages of CKD could have the opportunity for MBD screening with possible early diagnoses and then treatment. This project revealed gaps in the literature related to practice, research, and education as it relates to screening for MBD in CKD. Recommendations for further study have been offered. With early screening and treatment of MBD in this population, the mortality rate could possibly be reduced and quality of life improved. Early screening and treatment will lessen the burden of CKD locally, nationally, and globally.

Attainment of Leadership Goals

This project has contributed to my personal leadership goals in a number of ways. I feel more capable of conducting a systematic review of the literature and disseminating those findings into clinical practice. I am more knowledgeable about CKD and the many complications that occur because of this disease. I believe that these attributes will enable me to continue my work in this area and contribute to the healthcare community to improve patient outcomes.

Because of my work on this project I have been invited to work as an expert with WVDHHR Division of Health Promotion and Chronic Disease Prevention. The committee's initial task is to begin work with rural primary care clinics related to EMR prompts. Additionally, they are striving to gather more efficient data for the state related to CKD statistics and to explore the impact of this disease on our communities. I would serve as an interface between the committee and the clinical practice setting. I also hope to become involved with the re-designing of CKD educational materials for primary care practices in West Virginia. Additionally, I have become involved with the NKF for West Virginia. I am working as a volunteer in the community to screen patients who are at risk for CKD.

Finally, it is important to disseminate and teach what I have learned. I plan to expand my work in CKD specifically in education both in the community and clinical practice. I will continue to work with nursing students at West Virginia University, serve as a lecturer and mentor, and share my work and knowledge of CKD. In addition, opportunities for written and oral dissemination of this work both locally and nationally to the nursing community will be sought.

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Appendix A

Budget for Capstone Project Chronic Kidney Disease

Expenses	Estimated	Actual
Site		
Site Staff	$0.00	
Equipment	$0.00	
Totals		$0.00
Publicity		
Graphic Work	$28.90	$28.90
Photocopying/printing	$0.00	$0.00
Totals	$28.90	$28.90
Miscellaneous		
Educational Materials	$0.00	$0.00
Totals	$0.00	$28.90

Appendix B

LIVING WELL MEDICAL CENTER
828 Oakwood Road
Charleston, WV 25314

William J. Chapman, D.O.
Anna Holliday, FNP
304 346-4865

To Whom It May Concern:

April 20, 2010

This letter is to inform you that I, Dr. William Jarrod Chapman, agrees to and fully supports the practice change related to chronic kidney disease that Jarena Kelly, CFNP will be conducting in my office in the following months. If you have any questions in regards to this please do not hesitate to contact me.

Sincerely,

W. Jarrod Chapman, D.O.

Appendix C

Data Key

Variable #	Variable Name	Code	Explanation
1	ID	Patient record number	
2	Group Pre/post	1=pre 2=post	
3	Scr MBD	1=yes 2=no 3=NA	Was the patient screened for MBD?
4	Screening Lab Vitamin D	1=yes 2-no	
5	Calcium	1=yes 2=no	
6	Phosphorous	1=yes 2=no	
7	iPTH	1=yes 2=no	
8	eGfr	1=>90 2=60-89 3= 30-59 4= 15-29 5= <14	What stage of CKD did the patient have according to the record review of laboratory values.
9	S3dx	1=yes 2=no	Did the record have the diagnosis of 585.3 in the patient's record?
10	DX in record if determined they had it?	1=yes 2=no	If based on a review of the patient's lab it was determined that they had stage 3 CKD (585.3) was the DX missing?
11	250.00 DM	1=yes 2=no	
12	250.01 DM, UC	1=yes 2=no	
13	250.02 DM	1=yes 2=no	
14	272.4 Hyperlipidemia	1=yes 2=no	
15	401.0 HTN essential	1=yes 2=no	
16	401.9 HTN uc	1=yes 2=no	
17	585.3 Stage 3 ckd	1=yes 2=no	