Promoting Bone Health Through Utilization of a Nurse-Led Protocol

Millicent Mucheru

Touro University, Nevada

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DNP Project Chair: Dr. Rhone D'Errico

DNP Project Member(s): Dr. Terry Bartmus

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Abstract

Osteoporosis is a preventable chronic condition defined as low bone density with bone micro-architecture deterioration resulting in an increased risk of fragility fracture. Fragility fractures are associated with significant mortality, morbidity, and financial burden. Weight-bearing exercises and osteo-protective behavior modification can improve bone mineral density and reduce the incidence of fragility fractures, but deficits in the identification of at-risk patients have hindered efforts to intervene earlier in the course of disease progression. This project was designed to answer the PICOT question: Among telehealth nurses (P), does implementation of a nurse-led protocol for osteoporosis prevention (I), increase knowledge and efficacy of osteoporosis guidelines in comparison to those who did not use the protocol (C), and will it result in improved screening rates (O), four weeks after implementation (T)? The project was executed in two phases; an educational phase where a cohort of telehealth nurses were taught the fundamentals of osteoporosis screening and treatment including the use of a new Electronic Health Record (EHR)-based osteoporosis screening tool and an executional phase where the nurses used the new screening tool with patients through a telehealth platform. The FOOQ osteoporosis quiz and a Likert-like pre- and post-test survey were used to evaluate knowledge and opinions regarding osteoporosis screening and prevention in a cohort of telehealth nurses ($n=25$). Paired-sample analysis of the survey results suggested statistically significant improvements in both knowledge (pre- 13.96, post- 18.80, $p=0.00$) and opinion (pre- 19.52, post- 25.52, $p=0.0000017$). Although DEXA ordering in women > 64 years of age demonstrated a statistically significant increase post-intervention (p=0.0017827), DEXA ordering in women 50-64 years of age did not significantly change post-intervention (p=0.232388). These data suggest that although the educational intervention may have improved knowledge and opinions regarding osteoporosis, correlation between the educational intervention and DEXA ordering behavior could not be established.

Keywords: Bone mineral density (BMD), Dual-energy X-ray absorptiometry (DXA) or (DEXA), Fracture Risk Assessment Tool (FRAX), Facts on Osteoporosis Quiz (FOOQ), Telehealth nurses, Educational intervention

Dedication

For my being, and for life's countless blessings, I remain eternally grateful for the awareness of God's grace, unconditional love, and the countless miracles in my life. To my parents: thank you for instilling the love of learning in me, and teaching me the discipline to not be a quitter. To my husband Kihanya: Thank you for listening to my crazy ideas of going back to school, for feeding me and the boys, and dealing with my insane school and work hours. I could not have finished this project without your support. To my kids, S, S & S, you are my rock. Your continued love, support, and encouragement were pivotal to the successful completion of this journey. Thanks for leaving mom alone to "study". To my friends Nancy and Alice, thank you for giving me space that I needed to go through this program. I am grateful for your love and support.

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Introduction

Osteoporosis is an age-related skeletal disease characterized by decreased bone mineral density (BMD) that occurs when bone mass decreases more rapidly than the body's ability to replace it, resulting in substantial loss of bone strength (Cruz, Lins, Medeiros, Filho, & da Silva, 2018). Defined by the World Health Organization (WHO) as a "systemic skeletal disease characterized by low bone mass and micro architectural deterioration of bone tissue", osteoporosis leads to increased bone fragility and susceptibility to fracture (as cited in Modi, Sajjan, & Gandhi, 2014, para 3). Similar to hypertension, osteoporosis is a silent disease that does not exhibit any symptoms until a fragility fracture occurs. It is an incurable, chronic disease and is the most prevalent bone health issue for older adults in the United States (US) creating significant economic, social, and emotional burdens (Sabin & Sarter, 2014). It is, however, preventable and can be managed through a multi-faceted approach that includes physical exercise, early screening and diagnosis, osteoprotective behavioral modifications, and Vitamin D and calcium supplementation.

According to the International Osteoporosis Foundation (IOF, 2015a), women over 45 years of age spend more days in the hospital from osteoporosis than from diabetes, myocardial infarction, and breast cancer. Kling et al. (2014) reported that approximately 180,000 admissions to nursing homes and 432,000 to hospitals are due to osteoporosis-related injuries and associated illness. An osteoporosis prevention strategy has the potential to reduce the financial burden on society, prevent fragility fractures, improve quality of life, and promote population health (Goode et al., 2017). Osteoporotic fragility fractures lead to a reduction in quality of life, disability, frequent subsequent fractures, and increased morbidity and mortality. Fragility fractures related to osteoporosis affect 2 million people annually and remain the most serious complication of the disease and the greatest part of the disease-associated financial burden: It is estimated that the number of fractures will increase by half to 3 million fractures by 2025, leading to $25.3 billion per year being spent directly on osteoporosis-related medical costs including treatment of fractures in acute and rehabilitation care (Prah, Richards, Griggs, & Simpson, 2017).

The costs associated with osteoporotic fractures are significant and cause a substantial financial burden to society. The projected increase in osteoporosis and osteoporosis related fractures is especially concerning due to general rapidly rising cost of healthcare. Despite less public visibility, the risk and cost of osteoporotic fractures are actually greater than the cumulative risks of strokes, myocardial infarction, and breast cancer combined, and the cost of all major osteoporotic fractures in the US alone are expected to be greater than $18 billion by 2025 (French & Emanuele, 2019). If the rate of screening and treatment for osteoporosis continues to be suboptimal and osteoporosis prevention strategies are not adapted, osteoporosis threatens to further drain a fragile healthcare economy already straining under the burden of COVID 19. As the frontline deliverers of patient care, nurses are in an ideal position to promote osteoprotective behaviors by adopting theory-based and evidence-based initiatives to evaluate and educate patients. A nurse-led osteoporosis protocol can be used to establish a standard of practice in identifying high-risk patients and initiating strategies to promote bone health in the telemedicine department. Nurses can also improve Dual-energy X-ray absorptiometry (DEXA) screening rates by referring patients directly to the bone health department when indicated.

Background

A chronic disease with no cure (Wang et al., 2016), osteoporosis is defined by the International Osteoporosis Foundation (IOF) as porous bone disease caused by the reduction of density and quality of bone (French & Emanuele, 2019). Deterioration of bone tissue and low BMD results in osteoporotic fragility fractures that cause functional decline, debilitating chronic pain, disability, increases the risk of subsequent fractures, and increased morbidity and mortality. Without prevention and screening improvements, the cost of osteoporotic related fractures will place a significant burden in the U.S. healthcare system (Kling, Clarke, & Sandhu, 2014). Due to the current aging baby boomer population, the US alone will have 1.2 billion women who will be postmenopausal and suffering from osteoporosis by 2030, a significant public health concern (French & Emanuele, 2019). Further concerning is that 50% of people who experience an osteoporotic fracture will have a repeat fracture (French & Emanuele, 2019).

An osteoporosis preventative strategy such as the implementation of a nurse-led protocol requires interprofessional collaboration with all stakeholders including the telemedicine nursing staff, nursing leadership, the information technology department, the endocrinology department, the bone health department, and all primary care providers. Nurses, however, should take the lead in implementing osteoporosis prevention strategies, given their unique position as the first point of contact for patients. Nurses can use the advanced electronic medical record to complete a chart review for risk factors, identify care-gaps, and implement a strategy to bridge this gap through evidence-based intervention criterion to promote bone health.

An initial screening for osteoporosis will be used to identify at-risk patients and expedite treatment before a fragility fracture occurs, which is critical due to the lack of clinical manifestations. This risk assessment will also guide clinicians in the referral for BMD testing. Two osteoporotic risk assessment tools, Fracture Risk Assessment Tool (FRAX), and the Osteoporosis Self-Assessment Screening Tool (OST), have been developed and validated for the use in postmenopausal women. These assessment tools were developed to calculate major osteoporotic and hip fracture risk within ten years by evaluating a variety of known risk factors. The tools also accurately identify individuals at low risk for osteoporosis for whom routine BMD screening can be omitted as well as high-risk patients, and thus have potential benefits in terms of a reduction in screening cost and a lower rate of unnecessary radiation exposure (Pang & Inderjeeth, 2014). Assessment tools combined with evidence-based interventions can be successfully used for both primary and secondary prevention. These interventions include “adequate combined calcium and vitamin D intake (calcium alone has not been shown to reduce fractures), antiresorptive therapy, weight-bearing exercise, tobacco avoidance, moderate alcohol intake, and avoidance of trip or fall hazards” (Kling, Clarke, & Sandhu, 2014, p. 564). These tools also help identify patients who would benefit from DEXA scanning, the gold standard for measuring BMD for the diagnosis of osteoporosis. DEXA scans are helpful in not only predicting future fracture risk, but also as a guide in monitoring the effect of therapy (Drake, Clarke, & Lewiecki, 2015).

The morbidity and mortality associated with osteoporosis make this disease a public health concern particularly as the geriatric population continue to increase. Since osteoporosis has no cure, it is critical to identify early life influences on later BMD to aid the development of interventions to optimize bone health and reduce osteoporosis risk (Wood, Stenson, & Embleton, 2015). The future costs associated with the increasing numbers of fragility fractures in an aging population might overwhelm a fragile healthcare system (French & Emanuele, 2019) and yet the current literature support that osteoporosis prevention programs can reduce fragility fractures and therefore reduce the rising costs associated with osteoporosis. These preventative bone health strategies that include physical exercise, identification of high-risk patients for BMD screening referral, Vitamin D and calcium supplementation, and an optimal diet loaded with enough protein for bone health are not difficult to implement (French & Emanuele, 2019). Given the established body of research regarding the functional, clinical, and the burden of fractures to the healthcare system, fragility fractures and complications related to osteoporosis place a strain on the healthcare system that is largely unnecessary and eminently preventable (Claire et al., 2017). Thus projects such as this DNP quality improvement may prove essential in mitigating the impact of a growing problem in healthcare.

Problem Statement

At the project site, telehealth nurses are addressing patients' health concerns through a telemedicine platform, triaging symptoms and recommending appropriate treatment or disposition. The continued improvement of electronic health records enable nurses to identify care-gaps that have been missed and take appropriate action and order appropriate referrals. A needs assessment in the department revealed a significant knowledge gap, as nurses reported they do not know how to triage or address osteoporosis prevention beyond referring the patients to the healthy bones department. The lack of a nurse-led protocol and the deficient nurse knowledge was a barrier to the implementation of effective osteoporosis interventions on the unit.

Health care providers often miss opportunities to provide information about bone health in the elderly even though there is a vast amount evidence supporting active intervention to address the osteoporotic problem (Sabin and Sarter, 2014). Sabin and Sarter (2014), noted that clinicians have inadequate knowledge about osteoporosis prevention guidelines and lack the tools to quickly educate patients regarding osteoporosis prevention. Pang and Inderjeeth (2014), also reported that a large proportion of older adults in primary care do not undergo screening BMD tests or treatment, even if they report a history of minimal-trauma fractures despite practice guidelines recommending additional screening and interventions for these patients. The authors reported that this could be due to a variety of factors such as a gap in providers' education or the presence of more-urgent medical concerns, and recommended that providers use a decision-making tool or triaging process that would help identify individuals who need a BMD screen. Such a tool would also be beneficial by providing osteoporosis prevention education and recommendations for physical exercise as a deterrent for low BMD. Sabin and Sarter (2014), further recommended the implementation of an evidence-based osteoporosis prevention intervention project to increase osteoporosis prevention education by providers at an urban community clinic.

Rapidly improving healthcare technology and the progressive development of increasingly sophisticated methods of communication, coupled with the demand for novel approaches to care, has positioned nurses to collaborate and address health disparities through the use of telehealth technology (Fathi, Modin, & Scott, 2017). Telemedicine however, is still underutilized as an avenue to reach patients for health promotion, particularly for the prevention of chronic health conditions such as osteoporosis. To close the knowledge gap, there was a need for a nurse-led protocol to address bone health at the telehealth location. A carefully crafted screening tool with auto-populated information using the electronic health record had the potential to introduce osteoporosis preventative strategies when utilized by telehealth nurses working in collaboration with the healthy bones department. Such a screening tool was used to improve the triaging process and assist in the identification of high-risk patients.

Purpose Statement

The goal of the quality improvement project was to create a multifaceted osteoporosis preventative initiative that integrated a nurse-led protocol for osteoporosis screening in a primary care setting for telehealth nurses. The protocol incorporated a review of patients' medical history and a lifestyle questionnaire that guided telehealth nurses in the identification of at-risk patients and recommend referrals for BMD screening. The aim was to create an opportunity for telehealth nurses to recommend lifestyle osteoprotective modifications to improve BMD and increase DEXA screening rates.

Project Question

Nursing projects utilize the acronym "PICOT" as a framework of structuring questions for increased investigatory rigor in seeking and applying empirical data to practice problems (Elias, Polancich, Jones, & Colvin, 2015). The acronym stands for:

Population or Patient problem (P), Intervention or Issue of Interest (I), Comparison or Current Practice (C), Outcome (O), and Timeframe (T).The PICOT question for the quality improvement was: Among telehealth nurses (P), does implementation of a nurse-led protocol for osteoporosis prevention (I), increase knowledge and efficacy of osteoporosis guidelines among nurses in comparison to those who did not use the protocol (C), and will it result in improved screening rates (O), four weeks after implementation (T)?

Project Objectives

The purpose of the project was to achieve the following objectives at the practice site (i), Create a nurse-led protocol to be utilized by telehealth nurses (ii) Educate the telehealth nurses in the new "healthy bones screening" protocol (iii), Improve DEXA scan screening for postmenopausal women over 50 by 10% measured by auditing the clinic matrix (iv), Increase knowledge, clinical skills and efficacy among telehealth nurses in osteoporosis prevention to be measured by administering a pre-educational and post-educational test.

Review of Literature

Search Terms

An extensive search of the Touro online library and the project site's clinical databases using ScienceDirect, EBSCOhost, Ovid, CINAHL, ProQuest, and Sage was conducted to locate scholarly literature to provide the evidentiary basis for this project. There were ample resources available in the literature to support the project; a multi-database search of the term "Osteoporosis" produced 454, 239 results. Imposing preliminary selection criteria of peer-reviewed publications published within the last five years and written in the English language reduced the results to 88,598 possible sources. Guided by the PICOT question, additional search terms were then included to further reduce and sort possible sources for inclusion in the review. Terms used included "prevention," (64,405) "Guidelines," (25,809) "burden," (15,695) "risk-assessment," (6,115) "nursing knowledge," (3,498) and "quality improvement." (14,799) The top 100 returned sources for each sub-search were then hand-reviewed, first by title then by abstract for final inclusion in the review. Thirty-five sources were eventually selected for the project. In addition, fact sheets and statistical information from the International Osteoporosis Foundation were also included in the review. The remainder of this literature review is arranged thematically in the following order: Impact of osteoporosis, risk factors, evidence-based prevention, current management, and current recommendations.

Impact of Osteoporosis

With longer lifespans and therefore an ever-aging population in most parts of the world, osteoporosis, and related fragility fractures are a global public health concern (Sabin & Sarter, 2014). According to French & Emanuele (2019), the risk and cost of osteoporotic fractures is greater than the cumulative risks of strokes, myocardial infarction, and breast cancer combined. Osteoporosis is a preventable and treatable disorder with proven strategies to decrease the progression of bone mineral density (Kling et al., 2014). It affects more than 54 million Americans older than fifty-years of age and is expected to rise to 71.2 million Americans by 2030, leading to significant morbidity and mortality (Doyle, Kacmarynski, Beckett, Danley, & Kabadi, 2019). An estimated 40 million dollars is spent each day on the treatment of osteoporosis-related fractures, and if the costs of hospital, home care, nursing services, and loss of workforce are included, the total approaches 14 billion dollars a year in the US alone (Kalkim & Daghan, 2017). Osteoporosis was also predicted to be one of the leading causes of morbidity by the year 2020 (Dharmik, Worley, Volgas, & Crist, 2018). It is the most prevalent bone health issue for the elderly in the US, creating vast economic, social, and emotional burdens in the aging population (Sabin & Sarter, 2014). Fragility hip fractures are the most significant consequence of osteoporosis and result in a substantial loss of independence and an increase in morbidity and mortality (Cauley, 2018).

The National Osteoporosis Foundation (NOF), American Association of Clinical Endocrinologists, and American College of Endocrinologists all recommend that postmenopausal women over the age of fifty-years be assessed for risk factors for osteoporosis to determine the need for either BMD testing and vertebral imaging while the U.S. Preventive Services Task Force advises all women older than 65 years of age and men older than 70 years of age to undergo BMD testing (Doyle et al., 2019). Osteoporosis is more prevalent in women than men due to the sudden reduction in serum levels of estrogen at menopause. The lifetime risk of any osteoporotic fracture is 40% to 50% for women and 13% to 22% for men, which is markedly higher than other serious diseases such as diabetes or heart failure (Kling et al., 2014). As noted above, the increased prevalence of osteoporosis in postmenopausal women is due to the reduction of circulating estrogen, a hormone that is protective of bone health (Daly et al., 2019). Characterized by low bone mass structural deterioration and porous bone associated with higher fracture risk, bone loss is directly correlated to declining estrogen levels, contributing to the increase of fracture risk in postmenopausal women (Kling et al., 2014). By comparison, men do not undergo a menopausal equivalent and therefore, do not sustain the early-accelerated trabecular bone loss that occurs in women (Drake et al., 2015). With its silent progression, often the first indication of osteoporosis is a fragility fracture (French & Emanuele, 2019).

Risk Factors

Despite the availability of evidenced-based strategies to prevent osteoporosis, clinicians often do not provide adequate information to their patients about osteoporosis (Sabin & Sarter, 2014). DNP prepared nurses are charged with the evaluation of a healthcare problem at either the workplace or in the community and use empirical data to recommend solutions to the identified problem. Osteoporosis is largely preventable, and the impact of the disease can be reduced by understanding the disease progression, identifying risk factors, adapting physical exercises that promote osteoporosis prevention, and integrating behavioral modifications. The risk factors for osteoporosis are divided into modifiable and non-modifiable risk factors. The non-modifiable risk factors are gender (female), ethnic origin (Caucasian, Asian, Spanish), advanced age, and a family history of osteoporosis or fragility fractures. The modifiable, lifestyle-related factors include insufficient calcium intake, a sedentary lifestyle, smoking, excessive alcohol consumption, vitamin D deficiency, and excessive caffeine intake (Kalkim & Daghan, 2017). Early screening can guide prevention strategies to improve BMD since osteoporosis has historically been under-screened and therefore under-treated (Sozen, Ozisik, & Basaran, 2017). Survey results reported that 83% of patients without an osteoporosis diagnosis claimed that they did not receive any preventative education about osteoporosis, while 72.4% of patients with a diagnosis of osteoporosis likewise claimed they did not receive a preventative education (Dharmik et al., 2018). The diagnosis of osteoporosis did not guarantee that a patient would receive appropriate education.

Evidence-based Prevention

Nurses are guided by the assertion that the prevention of disease is better than the cure of one. Although pharmaceutical agents targeting BMD are the first line of osteoporosis prevention, they have no effect on improving other key risk factors, including low muscle strength, muscle power and functional capacity (Daly et al., 2019). Kling et al. (2014) emphasized the need for interventions to reduce fracture risk designed to be used for primary and secondary prevention. These interventions include adequate combined calcium and vitamin D intake, antiresorptive therapy, weight-bearing exercise, tobacco avoidance, moderation of alcohol intake, and avoidance of trip or fall hazards. Physical exercise and adequate calcium consumption are the two most important modifiable risk factors (Tan, LaMontagne, English, & Howard, 2016). Daly et al. (2019) argued that targeted exercise training is the only strategy that can simultaneously improve multiple skeletal and fall-related risk factors, but it must be appropriately prescribed and tailored to the patient and to desired outcomes. Prevention of falls is a significant component of preventing fragility fractures. Falls are the cause of most osteoporotic fractures and any preventative strategies for the effective treatment of osteoporosis must include strategies to prevent falls (Sozen, Ozisik, & Basaran, 2017).

According to Doyle et al. (2019), osteoporosis screening is an integral part of prevention and treatment. Studies completed by Dharmik et al. (2018) revealed gaps in practice in relation to osteoporosis prevention strategies and highlighted the need for the deliberate effort of a multidisciplinary team to coordinate all stages of osteoporosis management. To aid in the prevention of osteoporosis, it is essential for nurses to understand the pathophysiology of the disease. Doyle et al. (2019) explain that bones continuously remodel to maintain strength and to function as a reservoir of calcium and phosphorus with the age of peak bone density occurring in the early twenties. Osteoporosis develops as a result of suboptimal peak bone mass in young adulthood, excessive resorption of bone, or impaired bone formation during remodeling (Doyle et al., 2019). An understanding of pathophysiology helps explain the rationale of osteoporosis screening and why recommended interventions are effective.

Current Management

Current practice recommendations for the management of osteoporosis in primary care and/or telemedicine consist of both pharmacological and non-pharmacological interventions that vary in a patient-dependent manner according to disease risk and disease progression. These recommendations can generally be divided into measures designed to promote peak bone density in adulthood, measures to prevent bone loss after peak bone density is achieved, and measures designed to halt disease progression once osteoporosis has been diagnosed (Lewiecki, 2019). Early intervention begins in childhood, and should be focused on ensuring that children between the ages of 9 and 18 receive at least 1300 mg of calcium and 600 IU of Vitamin D per day to promote maximal bone density in adulthood (Lewiecki, 2019). Similarly, the avoidance of risk factors known to reduce bone density such as smoking and the excessive use of alcohol are particularly important in mid-to-late adolescence (Lewiecki, 2019). Diseases of bone formation such as osteogenesis imperfecta as well as diseases characterized by chronic systemic inflammation are also risk factors for poor peak bone density in adulthood and should be carefully managed in childhood and adolescence (Lewiecki, 2019). Weight-bearing exercise also supports the development of peak bone density, and is particularly important between the ages of 16 and 23 (Lewiecki, 2019).

The second stage of Osteoporosis prevention and treatment is designed to reduce the loss of bone density in adults after peak bone density has been achieved. The preventative measures for patients who have not suffered significant bone density loss or who have been diagnosed with osteopenia are similar to those recommended to ensure peak adult bone density (Lewiecki, 2019). Adequate intake of calcium (1200 mg per day) and of vitamin D (800 IU per day) are recommended, and among patients where poor eating habits and/or malabsorption limits dietary intake, supplementation of ≤ 1000 mg of calcium and ≤ 400 IU of 25-hydroxyvitamin D may be recommended (Lewiecki, 2019). The risk and benefits of supplementation with higher dosages of both elemental calcium and vitamin D are not well characterized and therefore high-dose regimens are not currently recommended (Lewiecki, 2019). As in adolescence, at least 30 minutes of weight-bearing exercise per day is strongly recommended for the prevention of bone density loss in adulthood (Lewiecki, 2019). Risk factors for osteoporosis in aging patients are similar to those found in younger demographics, and thus smoking and excessive alcohol consumption are both contraindicated for persons at risk for bone density loss (Lewiecki, 2019). Due to its association with accelerated bone loss, long-term therapy with glucocorticoids should be avoided if possible (Lewiecki, 2019). For patients with normal bone density or patients who are osteopenic, pharmacological intervention is not currently recommended although patients with high FRAX scores may be exceptions to this general practice recommendation (Lewiecki, 2019).

For patients with confirmed osteoporosis (a DEXA scan Z-score of < -2.5), in addition to the preventative measures detailed above, several pharmacological interventions are available (Lewiecki, 2019). First-line pharmacological treatment for osteoporosis consists of both bisphosphonates and the selective estrogen receptor modulator (SERM) Reloxifene (Lewiecki, 2019). Bisphosphonates are generally well-tolerated; however, care must be taken to ensure that patients receive appropriate counseling when beginning therapy since side effects can be severe if the drugs are not taken as directed (Lewiecki, 2019). Alendronate and risedronate are readily available, effective, and relatively inexpensive first-line bisphosphonates (Lewiecki, 2019). Reloxifene has a good safety profile and is an alternative to estrogen replacement therapy, which is not recommended due to an adverse risk-benefit ratio (Lewiecki, 2019). For patients unable to tolerate bisphosphonates, Zoledronic acid administered intravenously every 18-24 months is an option (Lewiecki, 2019).

Current Recommendations

Nurses benefit from an osteoporosis prevention protocol to promote osteoprotective lifestyle changes such as increased calcium intake and additional weight-bearing exercises as a means of preventing osteoporosis and promoting bone health (Kalkim & Daghan, 2017). Current literature recommends preventing the development of osteoporosis with a multifaceted, evidence-based strategy to increase BMD and decrease fragility fractures (Kalkim & Daghan, 2017). Nurses are in a unique position to promote behaviors and lifestyle modifications that promote bone health by conducting early discussions with patients meeting high-risk criteria for osteoporosis (French & Emanuele, 2019). Empirical data indicate that targeted physical exercise can deter the development of osteoporosis (Kling et al., 2014). Current recommendations include designing an evidenced-based nursing protocol to address high-risk patients identified through the electronic health record care-gaps. The multi-faceted preventative strategy was therefore designed to address Vitamin D supplementation if applicable based on recent test results, physical exercise recommendations, fall assessment risk, and referrals for DEXA screening for susceptible populations with risk factors.

The project adopted a patient-centered approach for the prevention of osteoporosis by designing a systems-based approach to bone health where telehealth nurses were educated on osteoporosis prevention, assessment, diagnosis, and treatment. Telehealth nurses can promote healthy bones by using an evidence-based care path and computerized reminder systems to promote bone health and provide lifestyle modifications to patients. Studies completed by Doyle et al. (2019) indicate that lifestyle modifications tailored to individual needs play a major role in the prevention of bone loss and protection against fragility fractures. The design of an osteoporosis protocol is critical as a screening tool that integrates lifestyle changes such as avoidance of caffeine, alcohol, and both active and passive exposure to tobacco smoke (Doyle et al., 2019).

Benefits of Current Recommendations

Through the assessment process, nurses are able to identify and determine each patient's risk factors for osteoporosis and incorporate an individualized osteoporosis preventative strategy. Determining the risk factors that lead to osteoporosis and declaring an early diagnosis have been evaluated as a more effective, easier and more cost-effective approach than treating advanced osteoporosis (Kalkim & Daghan, 2017). There is enough empirical data gathered from multiple studies that demonstrates that a well planned and executed theory-based educational intervention can be "effective in increasing consumption of foods rich in calcium and vitamin D or use of supplements, increasing participation in exercise, increasing BMD testing, and modifying other lifestyle behaviors that increase the risk for bone loss" (Smeltzer, & Qi, 2014, p. 29).

Integrating a system-based approach to bone health closed the knowledge gap in osteoporosis prevention by telemedicine nurses. A standardized workflow with questions prompting the individual nurse to cover the basics on lifestyle modifications strategies ensured compliance and consistency and standardized the triage process. For example, if the patient was over fifty-years old, a computerized prompt asked the nurse if the patient had Vitamin D levels tested or if BMD screening had been completed. To determine risk, other prompts required a yes/no response to risk factors such as glucocorticoid use (e.g., Prednisone), arthritis, a family history of hip fractures, smoking, caffeine use, age, and physical exercise regime or lack there of.

Such a workflow closed the knowledge and execution gap, as nurses were able to promote bone health and recommend BMD when indicated via the screening tool. A nurse-led protocol is critical in osteoporosis prevention since evidence in the literature indicates that despite proven strategies to prevent osteoporosis, clinicians do not provide adequate osteoporosis prevention strategies with their patients (Sabin & Sarter, 2014). The protocol may have potentially reduced the incidence of fragility fractures and promoted bone health through evidence-based preventative strategies that incorporated lifestyle changes and adaptation of physical exercise with weight-bearing exercises.

Review of Study Methods

As discussed by Rebecca Ingham-Bloomfield (2015), it is of critical importance for nursing-led interventions to be supported by the best possible evidence. The hierarchy of evidence is a systemic way of evaluating the quality of a study based primarily on experimental design that can be used to assign weight to practice recommendations found in the literature (Ingham-Bloomfield, 2015). Randomly controlled trials (RCTs) and the meta-analysis of multiple such trials sit at the apex of the evidentiary pyramid, yet for many interventions RCTs may not be available to support a desired quality improvement or intervention (Ingham-Bloomfield, 2015). The primary, secondary, and tertiary prevention of chronic illnesses such as osteoporosis frequently are difficult to study using RCTs due to cost, exceptional duration, or ethical considerations (Ingham-Bloomfield, 2015). Nevertheless, a few studies such as Vu Nyugen's (2017) meta-analysis of community-based osteoporosis prevention programs were largely based on experimental studies if not actual RCTs and were extremely valuable when developing this quality improvement. Individual RCTs were also valuable, particularly studies such as Kalkim and Daghan's (2017) work on the health belief model as it relates to osteoporosis education.

Cohort and case-control studies occupy the midrange of evidentiary quality, and are particularly appropriate for the study of chronic illnesses (Ingham-Bloomfield, 2015). Many of the review articles regarding the prevention of osteoporosis such as Drake et al.'s paper in Clinical Therapeutics (2015), were based largely on an extensive array of cohort and case-control studies with additional support provided by individual non-RCT experimental studies. These sorts of reviews make up a significant part of the literature regarding osteoporosis and are valuable for interventional development and also provide an opportunity to compare multiple reviews and find consensus recommendations. Less valuable but similar studies such as Lewiecki et al.'s micro-simulation based on cohort-level data (2019) were useful for suggesting the outcomes of interventions that were impractical or impossible to attempt but had bearing on this intervention's design. Finally, basic statistical sources from agencies such as the IOF and CDC were useful for providing prevalence data supporting the necessity of this intervention.

Significance to Healthcare

There is significant empirical evidence supporting the seriousness of osteoporosis as a public health concern if critical interventions are not implemented to prevent or decrease the progression of the disease. Osteoporotic fractures continue to rise with more than two million occurring each year in the US. Approximately one in every two women, and up to one in every four men aged >50 years will have an osteoporotic fracture in their lifetimes (Claire et al., 2017). The financial burden is significant to the patients, the healthcare system, and the US economy, making osteoporosis a serious public health issue.

Significance to Nursing

Since the time of Nightingale, the nursing profession has taken the lead in improving patient outcomes through the adaptation of best practices. DNP prepared nurses are scholar-practitioners who are prepared and have the knowledge to use empirical data to improve clinical practice. An evidenced-based osteoporosis nurse-led protocol closed the knowledge gap of the nursing staff and equipped them with critical thinking skills and efficacy needed for better outcomes. Nurses use the nursing process in their daily activities and are in a unique position to identify patients who need osteoporosis interventions due to the risk factors. The IOF has described the key role of nurses in making the public aware of the risks factors for osteoporosis and the need for osteoprotective behaviors through collaboration with other healthcare professionals on comprehensive osteoporosis prevention programs (IOF, 2015a). The IOF describes the responsibility of nurses in providing information on the risks, prevention, diagnosis, and treatment of osteoporosis to all individuals to whom healthcare is given (Kalkim & Daghan, 2017). Osteoporosis has many risk factors and many variables, but adequate screening and implementation of preventative measures can reduce fragility fractures and promote increased bone mineral density. Nurses are central to identifying risk factors, employing theory-based lifestyle modifications for bone health, and promoting wellness in the process.

Theoretical Foundations

Nursing theory provides the conceptual foundation upon which both the clinical practice of nursing and clinical practice improvements can be safely constructed (Yancy, 2015). As Yancy (2015) notes, little progress can be made in nursing science without the development and refinement of the discipline's theoretical basis. Models of behavioral change help clinicians understand why people do or do not adopt healthy behaviors, especially when change is required to either produce a positive clinical outcome or avoid an adverse event. Models describing patient behavior are particularly useful in identifying the variables that must be considered when designing nursing interventions as well as providing a framework to evaluate the effectiveness of an intervention post-implementation (Latifi et al., 2017). Patient and community educational programs are often delivered by theory-based programs (Nilson, 2015). A study completed by Turner & Wilory (2018), revealed the effectiveness of theory-based educational interventions in promoting both short-term and long-term osteo-protective lifestyle behaviors for the maintenance of bone density levels and the prevention of fractures. Thus, a nursing intervention designed to improve the prevention of osteoporosis must be firmly grounded in nursing theory. Two theoretical models have been selected for this intervention; one for development and one for implementation.

The Health Belief Model

History and Development

The Health Belief Model (HBM) is a widely used theoretical framework that provides a template for creating change in patient behavior to improve a specific health outcome, and was the theory selected to guide the development of this intervention (Lein, Turner, & Wilroy, 2016). The HBM is not a new theory, but one with roots grown out of 1950's public health policy (Jones et al., 2015; Rosenstock, 1974). Nevertheless, HBM remains one of the most frequently used models for patient behavioral change and motivation (Jones et al., 2015). Developed primarily by Irwin M. Rosenstock, Godfrey M. Hochbaum, S. Stephen Kegeles, and Howard Leventhal, the methodology of HBM has undergone revisions over the decades since its inception: Rosenstock himself frequently has written on the topic, including important updates in 1974 and later social scientists such as Matthew Becker and Nancy Janz have continued to refine the theory (Janz & Becker, 1984; Jones et al., 2015). The original theory was based on three assumptions about patient behavior, but as the model evolved an additional three tenets were added for a total of six guiding concepts (Jones et al., 2015; Rosenstock, 1974).

Guiding Tenets

The HBM asserts that a patient's decision to adopt behavioral change can both be modeled and subsequently influenced by considering specific components of the patient's health gestalt (Jones et al., 2015). HBM has evolved over the past 60 years, "to include six constructs: (i) perceived susceptibility; (ii) perceived severity, collectively known as perceived threat; (iii) perceived benefits; (iv) perceived barriers; (v) cues to action; and (vi) self-efficacy" (Bishop, Baker, Boyle, & MacKinnon, 2015, p.5). These tenets, operationalized for the purposes of intervention, are described below:

1. Perceived Susceptibility: In order to effect behavioral change, the patient must perceive that they are at risk for developing a specific condition or outcome (Rosenstock, 1974).
2. Perceived Severity: In order to effect behavioral change, the patient must perceive that the consequences of developing a specific condition or outcome are sufficiently undesirable to warrant avoidance (Rosenstock, 1974).
3. Perceived Benefits: In order to effect behavioral change, the patient must perceive that the benefits of adopting the change are significant enough to offset the effort of enacting the change in behavior (Rosenstock, 1974).
4. Perceived Barriers: In order to effect behavioral change, the patient must perceive that the barriers to behavioral change are well known and can be successfully surmounted (Orji, Vassileva, & Mandryk, 2012).
5. Cues to Action: In order to effect behavioral change, the patient must be exposed to a galvanizing stimulus strong enough to initiate action (Orji, Vassileva, & Mandryk, 2012).
6. Self-Efficacy: In order to effect behavioral change, the patient must believe that they have the intrinsic capacity and the personal resources to act (Orji, Vassileva, & Mandryk, 2012).

Thus, the HBM model suggests that in order to effect behavioral changes designed to prevent the development of osteoporosis, patients must believe they are susceptible to the condition, the severity of the condition warrants avoidance, there are clear and desirable benefits linked to the behavioral changes, and the barriers to change are surmountable (Kalkim & Daghan, 2017). Further, the patients must be exposed to a stimulus sufficient to promote action and believe that they are capable of enacting the necessary behavioral modifications (Kalkim & Daghan, 2017).

Applicability of Theory to Current Practice

A study by Smeltzer and Qi (2014) concluded that health belief in general and the belief in self-efficacy specifically played an important role in the adoption and maintenance of healthy behaviors for osteoporosis prevention including treatment adherence and compliance. A randomized control trial (RCT) conducted by Qi et al. (2011) reported statistically significant ($p = < .05$) improvements in self-directed exercise, medication adherence, and knowledge of osteoporosis two weeks after an intervention modeled on influencing health beliefs and self-efficacy. Similarly, a systematic review conducted by Ryan, Schildt, and Ryan (2013) found that interventions to improve calcium intake amongst patients at risk for osteoporosis were more likely to succeed if modeled on a health belief and self-efficacy modifying theory. More recently, Kalkim and Dagham (2017) used the Health Belief Model as the theoretical framework for an RCT-like osteoporosis intervention targeting at-risk women between the ages of 30 and 45. The authors found that compared to their control group, the experimental group had significant post-intervention improvements in all sub-scales of the Osteoporosis Knowledge Test, duration of exercise, and calcium intake (Kalkim & Dagham, 2017).

The goal of using theoretical nursing models is to explore the most effective strategy based on solid evidence for population health improvement (Nilson, 2015). Smeltzer and Qi (2014) noted that health beliefs and self-efficacy play an important role in the adoption and maintenance of healthy behaviors for osteoporosis prevention and treatment adherence and compliance. Thus, the HBM model is perfectly suited for this kind of intervention. A later study completed by Turner & Wilory (2018), revealed the effectiveness of health belief theory-based educational interventions in promoting both short-term and long-term osteoprotective lifestyle behaviors for maintaining bone density levels and preventing fractures. Thus, as the most widely used model for healthcare behavioral change, The HBM and its attention to the perceived susceptibility to illness, perceived severity of the outcome, perceived benefits of taking positive actions, and perceived barriers to engaging in protective behaviors which are frequently underestimated or unknown to at risk patients well supported the aims of this project (Lein, Turner, & Wilroy, 2016).

Applicability to the DNP project

The HBM is significant and relevant to this project since it promotes behavior modifications for bone health through lifestyle changes (Turner & Wilory, 2018). Telehealth nurses needed to acquire the knowledge and skills to assess risks for osteoporosis and to use the HBM to impact patient behavior. The HBM guided the development of a protocol that the nurses utilized to inform patients of their risks and how behavior modifications might reduce those risks; as the key stakeholders in the project, the nurses stood as the primary change agents in this project (Rafferty, 2018). As noted by Rafferty (2018), as the largest portion of the workforce in healthcare and the position with the most direct patient contact, nurses are perfectly poised to use the HBM framework to incite change in patient behavior. As discussed above, research indicates that patients are more likely to be compliant with health modification behaviors if they are aware of the perceived susceptibility to the disease: Nurses therefore serve as a conduit to successfully fulfill at least one tenet of the HBM simply by making patients aware that they are at risk for osteoporosis (Rafferty, 2019). Using the HBM as a framework, nurses and other clinicians are able to understand how patients' perceptions of benefits, threats, cues to action, and self-efficacy play a role in the likelihood of patients becoming involved in safety practices (Bishop et al., 2015). As such, the HBM provided a model for patient care that is directly correlative with the patient-centered concept of care used in nursing practice today.

Kotter's Theory of Change Management

Although the HBM provides an elegant model for the design of a nursing intervention as it relates to impacting patient behaviors, it does little to direct how the intervention itself should be staged and structured. Thus, a second theory was selected to guide the implementation phase of this project; the Kotter theory of change management. Change has been a constant part of the human experience and change management theory is a relatively recent development (Nilsen, 2015). As noted by Kumar, Kumar, Deshmukh, and Adhish (2015), the fundamental characteristics of both individuals and organizations such as character, core beliefs and values, and overall vision are typically refractory to change. Within the boundaries imposed by these individualized truths however, organizational and personal change can be modeled and effected (Kumar et al., 2015). Thus, implementation science exists to guide organizations in their efforts to create and sustain meaningful, positive change. Nilsen (2015, para. 1) suggests that, "theoretical approaches used in implementation science have three overarching aims: describing and/or guiding the process of translating research into practice (process models); understanding and/or explaining what influences implementation outcomes (determinant frameworks, classic theories, implementation theories); and evaluating implementation (evaluation frameworks)". These aims fit well with the implementation of a practical quality improvement, yet linking theoretical approaches to nursing with the practice of nursing can be challenging for nurses and administrators, and the use of change modeling is no exception (Kumar et al., 2015). Nevertheless, applying a codified framework to this project was essential to its success and thus Kotter's model was chosen.

A quality improvement initiative should be implemented with a clear outcome in consideration. Outcome evaluation is a critical component of any quality improvement intervention strategy. Evaluating the effectiveness of the interventions can weigh what worked, how it worked, and what outcomes matter and which outcomes have the capacity to improve health, and the implementation context (CDC, 2017). Evaluations enable the collection of data to analyze if desired outcomes such as behavior change have taken place and is a measure of successful implementation. The kotter's model was also used for evaluation since it is well structured and easy to follow and is adaptable to any practice environment where a practice change needs to be implemented (Small et al., 2016). As proposed by the model, it is important to establish a need for change and create a sense of urgency where implementation is followed by data analysis to identify strategies that are effective in achieving desired outcomes (Baloh, Zhu, & Ward, 2018).

Continuous evaluation is critical since it reveals strategies that are effective or need modification or should be completely discarded. Kotter's model step of institutionalizing the change was achieved when Telemedicine nurses solidified the questionnaire as part of their daily activities: It became the norm (Small et al., 2016). This behavior change signifies efficacy in osteoporosis screening and was one of the desired outcomes. The increase in the use of DEXA scanning when appropriate and the prevention of fragility fractures was the long term goal, however.

History and Development

Historically, codified change management can be traced to Kurt Lewin's three-step theory of planned change later modified by Ronald Lippitt to include seven distinct phases (Barrow & Toney-Butler, 2019). According to Lewin, transformative organizational change takes place in three stages; an unfreezing phase where change is recognized as necessary, a movement phase where change is initiated, and a refreezing stage where the alteration becomes the norm (Barrow & Toney-Butler, 2019). Although Lewin's model was of great importance due to the novelty of codified change management theory in the 1950's, it is difficult to operationalize. Later theories by Lippitt and then Kotter were designed to create a structure for the execution of change rather than simply describing how one might occur (Nilsen, 2015). With each successive theory beginning with Lewin and ending with Kotter, the tenets become more action-oriented. Kotter's theory, in fact, can be used as a guide for specific actions that must be taken by the lead change agent at specific points in the change management process (Appelbaum, Habashy, Malo, & Shafiq, 2012). Thus, the Kotter change model was selected for this project to provide a model for each action-oriented step of the change process.

Guiding Tenets

Kotter's model, developed in 1995, describes eight discreet steps in the process of enacting change (Aziz, 2017).

1. Create urgency: This step is defined by the creation of this document; the aims, rationale, and supporting theories must compel stakeholders to support enactment of an osteoporosis prevention intervention.
2. Form a powerful coalition: This step will be defined by identifying and subsequently recruiting stakeholders at all levels of the organization both academic and professional so that necessary physical resources, personnel, and institutional authority to act are included immediately.
3. Create a vision for change: This step will be defined by the creation of compelling materials; written, verbal, and multimedia, that compellingly illustrates the improved future reality envisioned by the project's aims.
4. Communicate the vision: This step will be the delivery of the previously created materials to all stakeholders so that each participant is galvanized to action.
5. Empower action: This step will be defined by the removal of emergent barriers to successful implementation of the intervention as they become apparent and the constant and consistent provision of support, materials, and feedback to the interventional team as the project progresses.

6. Create quick wins: This step will be defined by the celebration of early successes in the implementation of the project, even though data may or may not be yet available.
7. Build on the change and don't let up: This step will be defined by the collation and reporting of data as it becomes available to executive stakeholders so that early results can be evaluated, and if warranted the program can be expanded or adjusted to improve performance. Providing positive, supportive feedback to the staff as the project evolves will also support this tenet.
8. Make change stick: This step will be defined, pending significant positive impact of the intervention, by the creation of procedure and protocol in support of the aims of the project so that the practices developed here in become part of the institutional culture.

Each step was carefully modeled in the methodology of this intervention. As noted by Aziz (2017), the stepwise nature of the Kotter model allows for efficient planning since each transition can be anticipated and structured for peak impact and efficiency.

Applicability of Theory to Current Practice

There is ample evidence supporting the use of the Kotter theory of change management for quality improvement projects in healthcare. A recent paper by Ann-Marie Aziz (2017) provided a detailed discussion of how Kotter's change management theory might be used to reduce the risk of needle-stick accidents in an inpatient hospital setting. Although this paper was not a discussion of the results of an actual RCT implementing the suggestions contained therein, it did provide a specific description of how Kotter's theory could be applied in nursing practice (Aziz, 2017). Similarly, Neumeier's (2013) paper on the implementation of EHR systems also relied on Kotter for its theoretical foundation. In actual practice, Kotter's theory has proven to be quite effective. Small and et al. (2016) used Kotter's model to design and execute a quality improvement designed to increase the effectiveness of on-unit bedside patient handoffs; the authors noted that Kotter's model was essential to the successful completion of the project. Mørk, Krupp, Hankwitz, and Malec (2018) also used the Kotter model to implement two overlapping quality improvements; both bedside handoffs and interdisciplinary rounding were targeted for improvement. As noted by the authors, "Kotter's 8-Step Process for Leading Change is recognized as a successful change framework applicable to many environments. This model outlines a series of sequential steps to facilitate and sustain change." (Mark et al., 2018, p. 40).

Applicability of Theory to DNP Project

The applicability of the Kotter change model has been demonstrated by the theoretical and practical successes of previously published projects (Mark et al., 2018, Small et al., 2016). Although Lewin's theory has frequently been used to design quality improvements in healthcare, the action-orientation of the Kotter model made it a better fit for this project. As noted above, the eight steps of the model allowed for a specific set of actions with subsequent goals to be organized in a linear manner even though in actual practice, steps overlapped and the process even regressed at times (Applebaum et al., 2012). Because each step in the process is so carefully prescribed, previously published projects can be used to suggest action steps for each of the eight stages of the change process, allowing for efficient project design and execution.

All eight steps of the Kotter change model directly applied to and guided the successful completion of the project. The creation of urgency was the cornerstone of the earliest stages of the project. Without making a well-supported argument for the critical need for the project, stakeholders would have lacked the necessary level of buy-in that was needed to ensure active and effective participation by all necessary personnel. The second tenet, build a strong coalition, is an extension of the first tenet and was equally important to the success of the project. Creating urgency in a limited subset of participants would have correspondingly limited impact on project success, but creating urgency in a sufficiently wide set of stakeholders ensured that material support, logistic support, executive support, and execution support was available as needed throughout the duration of the project. The creation of a change vision was accomplished simultaneously with the execution of the first two Kotter tenets; the vision to include the projected actionable steps of the intervention was used as the source material to drive both coalition building and the creation of urgency; communication, the fourth tenet, is inherently a part of the first three tenets discussed here in.

As with the first four tenets, the second four are interconnected and were all directly related to the success of the project. Empowerment is crucial to maintaining urgency throughout the execution of a project, and part of empowerment is the creation of and reporting of quick wins to the team; empowerment and quick wins are tenets five and six. Quick wins in particular are critical, because interest in a project can quickly wane if the individual participants feel that their personal contributions are either unappreciated or irrelevant. Celebrating wins can preserve the buy-in of stakeholders at all levels. The last two tenets are also connected. Building on change is critical because there were emergent issues that could not have been anticipated that arose throughout the duration of the project. It is also difficult to project which portions of the project will be the most effective and which will be ineffective. Thus, as the results of the intervention were initially evaluated, mid-course alterations to adapt to what was and was not working were necessary. This is the idea of building on change; the project must be a living work and not a static program. Responsiveness throughout the project eventually lead to the final tenet demanded by Kotter; make change stick. It was the goal of this project to make meaningful improvements in the screening and potential treatment of osteoporosis. Adapting the program throughout to a final, extremely effective intervention has created the lasting change that was the ultimate goal of the project. All of Kotter's tenets directly applied to the project and all were necessary components to ensure project success.

Project Design

Despite efforts to improve the delivery of healthcare in the United States over the past two decades, it is estimated that the gap between the care that should be delivered and the care that is actually received by patients results in a combined $11 billion dollars a year in wasted money for healthcare organizations, in addition to the obvious deleterious impact on patient well-being (Varkey, Reller, & Resar, 2007). According to Christine Hedges, "Quality has been defined as 'the degree of excellence possessed by a product, service process, or workforce.'" (2009, p. 10). Further, Hughes defines quality in health as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (2008, p. 3-1). A quality improvement therefore is a process, usually continuous, that is designed to make incremental positive changes in an outcome measure of interest in a clinical population (Hughes, 2009). Since by definition, most quality improvements take place at the end-point of clinical healthcare delivery, it has been suggested that nurses and nursing leaders should be the driving force behind the majority of quality improvement initiatives (Varkey, Reller, & Resar, 2007). Since this project was dedicated to improving several important clinical outcomes in a specific population, a quality improvement design was the obvious choice. This project was a DNP-candidate lead quality improvement intervention at the microsystem level designed to implement and evaluate a nurse-led smart questionnaire as a risk-screening and intervention tool at a single telemedicine central messaging department in Los Angeles, California (CA). The implementation included the evaluation of telehealth nurses' efficacy in addressing osteoporosis concerns through a survey and pre-test. This was followed by trainings designed to teach the current guidelines of osteoporosis preventative strategies and the healthy bones protocol.

The project focused on the design of a nurse-led protocol for osteoporosis screening that was used as a guide for the promotion of osteoprotective behaviors. The design of the questionnaire was selected both because of its applicability to the stated objectives of the project and also due to its congruence with ongoing continuous quality improvement methodology at the project location. Remote screenings using treatment algorithm linked EHR tools implemented by nurses have been successfully used to detect and treat a number of diseases such as COPD and other chronic respiratory disorders (Hernandez, C., Mallow, J., & Narsavage, 2104). In a study with similar goals to this quality improvement project, Mansberger et al. (2018) found that patients identified as high risk for diabetic retinopathy during nurse-led telemedicine screenings were more likely to submit for retinal evaluation than controls that were not exposed to the telemedicine intervention. The intervention focused on the use of the smart questionnaire integrated into the EHR that auto-populated with pertinent patient data such as age, gender, medical history, and provided proactive care recommendations. The smart questionnaire identified at-risk patients and then linked to a proactive care algorithm that prompted the nurse operating the system to assign appropriate recommendations based on the answers to the osteoporosis screening smart questionnaire. Such recommendations included the increase of physical exercises and Vitamin D supplementation or DEXA screening if indicated. These interventions aligned with the project's objectives of increasing clinical skills and efficacy among telehealth nurses and creating a nurse-led protocol as a guide for proactive care recommendations with the ultimate goal of increasing DEXA screening rates.

Previous studies included the successful implementation of an osteoporosis-screening questionnaire in an orthopedic trauma clinic that produced clinically significant improvement in the identification of at-risk patients (Goode et al., 2017). A similar questionnaire has also been used successfully to evaluate the risk of developing Type 2 diabetes mellitus (T2DM), and proven to be an accurate, low cost, educational and time-efficient method for assessment (Rowan et al., 2014). In T2DM, the risk assessment questionnaire is used as a tool to select high-risk groups, to personalize prevention messages, and change preventive behavior among high-risk populations indicating that it is an acceptable tool for public health approach (Wijdenes, Henneman, Dondorp, Cornel, & Timmermans, 2016).

T2DM and osteoporosis share several common features suggesting a similar approach to screening and prevention may be effective for both. Both T2DM and osteoporosis are usually asymptomatic until irreversible negative health impacts have already occurred and more critically, both can be delayed if not prevented by early intervention by initiating medical treatment and precipitating lifestyle changes (American Diabetes Association, 2018; Kling, Clarke, & Sandhu, 2014). As noted by Marcoux, Chouinard, Diadiou, Dufour, and Hudon (2017), patients with diagnoses of T2DM and/or osteoporosis are at risk for high utilization of health services and thus interventions to deter or slow the onset of either disease will help elevate the socioeconomic burden associated with chronic disease. It was therefore feasible that the implementation of an osteoporosis screening tool that is used as a checklist in the identification of risk factors and promote osteoprotective behaviors could be successfully integrated into the telemedicine department (Goode et al., 2017).

The Kotter change theory framework previously discussed guided all three phases of the project. A detailed timeline was included with the project proposal. The project was conducted in three phases consisting of a pre-implementation phase, an active implementation phase, and a post-implementation analysis phase. The first goal of the pre-implementation phase was to, in conjunction with multiple stakeholders at the facility, build and test the system modifications that were required during the implementation phase. Although the smart-questionnaire and survey tools were already built, they were not integrated into the EHR management system until the commencement of implementation phase of the project. Extensive testing of the smart questionnaire once built ensured that the product was stable, intuitive, and minimally disruptive to normal clinical workflows. The successful completion of this part of the project was critical since the implementation phase relied almost entirely on the quality of the product developed in this phase.

The second goal of the pre-implementation phase was to educate the participating nurses about the intervention and encourage buy-in into the process. Initial communication of the quality improvement was conducted via email, and then followed up by a series of conversations held during pre-shift huddles over a one-week period to allow for coverage of the entire cohort of participants. Once the intervention had been effectively communicated to the participants, the final goal of the pre-implementation phase was designed to allow the participating nurses to become skilled at using the new smart questionnaire 4 weeks prior to data collection. The smart questionnaire (see Appendix A) was activated in the EHR, and the participant nurses were given feedback on their use of the tool before the commencement of the active implementation phase. At the end of the pre-implementation phase, the participating nurses completed the pre-survey and the data was recorded and stored for later analysis and comparison to post-survey results.

The primary goal of the implementation phase was to monitor and adjust the utilization of the smart questionnaire introduced during the pre-implementation phase. Critical activities during this phase included collecting data from the EHR as the project progressed, providing feedback and support for the nursing staff during the active phase of the project, interfacing with all levels of the organization to provide ongoing updates on the quality improvement, and making adaptations as needed due to unforeseen systematic, organizational, and/or human capital difficulties as they evolved. At the conclusion of the implementation phase, the participating nurses completed the post-survey.

The primary goal of the post-implementation phase was the analysis of the data collected during the first two phases. At the completion of the post-implementation phase, the final results of the quality improvement were documented; conclusions were drawn, and recommendations for future projects/quality improvements were determined. The implementation met the purpose of the project which was to design a nurse-led protocol as a tool for osteoporosis screening, train the telehealth nurses' in the use of the protocol, increase their efficacy and clinical skills in osteoprotective guidelines, and increase DEXA screening rates for the target population.

Population of Interest

Participants were recruited from the nursing staff of a Telehealth department of a healthcare facility in Los Angeles, CA (*n*=25). The Registered Nurse (RN) staff (*n*=14) was comprised of five per diem workers, two part-time, and seven full-time employees. Of the 14 RNs, 2 are Advanced Practice Registered Nurses (APRNs) and two hold Bachelor of Science in Nursing (BSN) degrees. The remaining members of the nursing staff were all Licensed Vocational Nurses (LVN's) (*n*=11) with two being per diem workers and the other ten full-time employees. The nurses' ranged from 20 to 56 years of age. Additional demographic data was collected during the project including age, level of professional licensure, and the highest level of educational attainment. Written permission was obtained from the site administrator and is included in Appendix D. Inclusion criteria were any nurse working on the unit during the project time period. This included all new hires that had successfully completed onboarding and probation periods.

Exclusion criteria included any nurse who was on extended leave of absence during the project period and any nurse hired during the project period that did not assume regular duties until after the end of the implementation phase.

Setting

The setting of this project was the department of Telemedicine Central Messaging at a healthcare clinic in Los Angeles, CA where nurses interact with patients through the telephone or via email rather than providing face-to-face care. The telemedicine department provide support for five additional medical buildings through a centralized messaging center where all telephone and email encounters are routed to the department. Covering both internal and family medicines, telehealth nurses interact with approximately five hundred patients on a daily basis through telephone and email encounters.

Stakeholders

Stakeholders included the telehealth department nursing staff, nursing leadership, primary care providers and nurse practitioners, healthy bones department, information technology department, healthy bones nurse practitioners, executive leadership, and patients. The process of the Institutional Review Board (IRB) approval required many steps and partnership between several disciplines. The initial step of this project was to discuss the proposal with the Telemedicine department manager. After obtaining clearance from the manager, consultation with the medical building healthy bones department was initiated to obtain buy-in. This was followed by a presentation to the quality department committee, regional health bones department, regional nursing committee, nursing leadership, and finally to the IRB committee. Once approved, the project was presented to site leadership, and then a planning meeting held with nursing leadership in the department to prepare for the pre-implementation and implementation phases. Initial communication of the quality improvement to the participating nurses was conducted via e-mail, and then followed up by a series of conversations held during pre-shift huddles over a sufficient period of time to allow for coverage of the entire cohort of participants. Participation was mandatory for all nurses working in the telemedicine department in the facility. A Power-point presentation covering osteoporosis epidemiology, prevalence, risk factors, preventative measures, and evidenced-based current guidelines for screening was provided and is included in Appendix E. Since participation was mandatory, no advertising was conducted and participation in the quality improvement was not be incentivized in any way.

Tools/Instrumentation

The Facts on Osteoporosis Quiz (FOOQ) located in Appendix C, is a tool for knowledge assessment that was selected to measure the participating nurses' general level of proficiency with osteoporosis information before and after the quality improvement. The FOOQ has been used to assess knowledge of osteoporosis in previous studies and has been reported to have a satisfactory validity and reliability (Park, Lee & Koo, 2017). The tool was chosen for this project due to its established validity as an effective instrument that has been used successfully to evaluate patients' knowledge of osteoporosis (Fischer at el., 2018). According to Ailinger, Lasus, and Braun (2003) who revised the FOOQ in 2000 and reduced the number of questions from 25 to 20, the survey had an internal content validity of 0.87, a Chronbach alpha of 0.76 indicating adequate reliability, and a reading level of approximately sixth grade. Of the questions, only two fell outside of the item discrimination goal of 20% or less (Ailinger, Lasus, & Braun, 2003). Scholarly literature reviews that the FOOQ tool has also been used successfully to assess the knowledge among nursing staff regarding osteoporosis and its risk factors (Dwidmuthe, Dwidmuthe, Abhinavkumar & Somalwar, 2017). The FOOQ tool consists of twenty true-or-false questions assessing for osteoporosis knowledge in relation to epidemiology, risk factors, prevention, and treatment (Fischer et al., 2018).

The FOOQ was developed in 1988 with the goal of creating a brief quiz to generate an instrument of minimal length with acceptable validity and reliability and has been widely used by clinicians, educators and the general public (Ailinger, Harper, & Lasus, 1998). Responses of a "true/false/don't know" format was chosen for the FOOQ because such questions are quick to answer and uncomplicated to score and the "don't know" response differentiates between misinformation and lack of information and reduces guessing (Ailinger, Harper, & Lasus, 1998). Although the tool was first developed in 1988, it has been continually updated in alignment with the current National Institutes of Health (NIH) consensus statements on current scientific evidence on osteoporosis (Fischer at el., 2018). The initial FOOQ consisted of 25 items for osteoporosis knowledge evaluation but the modified FOOQ only consisted of 20 true/false questions which are based on a consensus reached during the 2000 NIH osteoporosis conference (Park, Lee & Koo, 2017).

Implementation of the smart questionnaire utilized a novel tool that was vetted by three professional experts for validation. This was a two-part screening and treatment algorithm that was programmed and integrated into the EHR at the facility. The questions that were included in the screening instrument are included in Appendix A. The second portion used an intervention matrix algorithm that was also programmed into the EHR, and auto-populated with intervention options depending on the answers to the screening questions. A sample of the flow logic is provided in Appendix B. The FOOQ tool was used to measure participants' confidence and knowledge of osteoporosis and was hosted on Qualtrics and has been included in the same appendix.

Cognitive interviewing methods were used to assess the instruments for ease of use, clarity of questions, and consistency of answers. Additionally, three experts have reviewed the questionnaire for comprehensibility and scope and for CVI after which the questionnaire was finalized. The data was then analyzed using the statistical package for social science for MAC (SPSS) version 22. The Statsplus plug-in for Excel was used to analyze the results of the Likert-like portion of the pre- and post-survey. Demographic characteristics and scores on the questionnaires were summarized using descriptive summary measures and expressed as mean ± standard deviation for continuous variables and percentage for categorical variables. A p-value of 0.05 was considered statistically significant.

Data Collection Procedures

The novel instrument was used for the execution of the smart questionnaire for this quality improvement project and data was collected either by each tool directly or from EHR records indirectly. For the FOOQ instrument, scoring logic was built into the survey design and produced two subscale scores; one score for basic knowledge and one for nurses' level of confidence in the knowledge of the application of osteoprotective strategies. Demographic information collected included age, gender, level of education, and years of service in the department. The data from the survey was downloaded in the form of an excel spreadsheet and was password protected. Once data analysis was complete, all personal identifying information was deleted and the entire data set will now be securely stored for a period of five years. From the EHR, before and after data was collected monitoring the ordering of DEXA scans. All personal identifying data was removed prior to analysis and raw changes in ordering trends were evaluated without attached patient data. As possible, usage data for the EHR screening and intervention tool was collected and analyzed. Anonymized data for DEXA screening rates was extracted from the EHR with the assistance of a statistician. All data was deleted when the project was completed and remained password-protected until deletion. The anonymized data was reviewed by the researcher with the department manager.

Project Timeline

Pre-implementation phase (2 weeks)

After obtaining the approval letter from the telemedicine department manager located in Appendix D, the projected timeline for the quality improvement project with calendar dates was shared with the relevant stakeholders at the practice site. The timeline did not require alteration, based on the date the quality improvement was approved for implementation, with July the original target for the active implementation phase. Two weeks before the beginning of the implementation phase or I-2, the screening tool requirements was released to the IT department, and partnership was forged with IT leadership to ensure timely coding of EHR upgrade. An introductory e-mail was concurrently released to all participating nurses, explaining the intervention and providing a timeline for the project. At this time, the FOOQ questionnaire and the survey were provided to participating nurses to measure their knowledge of osteoprotective strategies. The collected data from the FOOQ instrument was percentage tracked for post-implementation comparison. Presentation of the project was made to the senior leadership at the facility and follow-up was conducted as needed to coordinate the preparations for the quality improvement implementation. Partnership with leadership was ongoing and a continuous process. One week prior to the implementation phase or 1-1, the functionality of the EHR upgrade was validated with the IT department to prepare for the training of the participating nurses.

One week prior to the implementation phase or I-1, discussions with all nurse participants were held during morning/evening/pre-shift huddles to prepare the nursing team for project implementation. Bone health training was conducted by the project lead during these huddles and handouts distributed to nurses. Handouts describing the operation of the new tools were provided to the participants and are located in Appendix E. The EHR modifications were activated three days prior to the beginning of the implementation phase and the nurse participants learned how to use them in real-time on patient calls. Performance with the new smart questionnaire was monitored by the project lead through feedback from the nurses and support was provided as needed. The project lead monitored each nurse to ensure he or she was comfortable using the smart questionnaire and addressed any concerns that they had. Nurses were also requested to provide feedback through verbal communication or emails if the project lead was not available. All verbal communications were anonymously transcribed by the project lead and maintained in an electronic file along with participants emails for review. Any system modifications discovered through the process of monitoring or feedback and deemed necessary was made at this time

Implementation phase

At the beginning of week 0 or week I-0, the quality improvement officially began and data collection started. Performance was monitored throughout the implementation phase via EHR data collection. During week 3, or I+3 a mid-project meeting with senior stakeholders was formally held to discuss initial results of the quality improvement. Any necessary adjustments to the project were planned and executed at this time. Week 4 or I+4 concluded the active implementation phase. A formal meeting with senior stakeholders to discuss continuation/termination of the quality improvement was conducted. Finally, at the end of week 4 or I+4 (end) the post-survey was distributed via e-mail.

Post-implementation phase (1 week)

Week 4 or I+4 was marked the beginning of data analysis. This period concluded on week 5 or I+5 with completion of the final draft of the results of the quality improvement project and the distribution of these results to all relevant stakeholders. The original timeline and project grid is included below *(Figures 1,2)*:

Week	Activity	Participants (Responsible Party)
I-2	1. Meet with IT team for software build	1. IT Leadership, Project lead
	2. Meet with facility leadership regarding QI final planning	2. Nursing leadership, Executive leadership, Telehealth Manager, Project lead

	3. Draft and send E-mail to all nursing leaders and participants post-leadership meeting	3. Project lead
	4. Delivery of FOOQ survey (e-mail link delivery, separate e-mail) to all nurse participants	4. Project lead
I-1	1. Meet with IT and verify successful project build	1. IT project manager or Department Manager as needed, Project lead
	2. Hold morning meetings and staff huddles to discuss project with nurses, distribute training materials at the meetings	2. Project lead, participating nurses
	3. Activate screening tool in EHR for live training (post staff meetings and huddles)	3. Project lead, nursing leadership, participating nurses, IT project manager
	4. Validate tool functionality and data collection	4. Project lead, IT project manager

I+0 to I+2	1. Begin recording and tracking data from the EHR tool	1. Project lead, IT project manager
	2. Hold ongoing morning huddles to discuss the project, any challenges, celebrate wins, and provide feedback	2. Project lead, nursing leadership, participating nurses
I+3 to I+4	1. Hold ongoing morning huddles to discuss the project, celebrate wins, and provide feedback	1. Project lead, nursing leadership, participating nurses
	2. Hold Mid-QI meeting with facility leadership to discuss early results, barriers, wins, and needs	2. Project lead, facility leadership, nursing leadership, IT leadership if needed
	3. Distribute FOOQ post survey to participating nurses at end of week I+4	3. Project lead, participating nurses
I+5	1. Collect and collate final data from surveys and EHR tool for analysis	1. Project lead

	2. Conduct statistical analysis and assess results	2. Project lead, statistician
	3. Document results and write up final results including interpretation and suggestions for future quality improvement	3. Project lead

Figure 1. Project Timeline

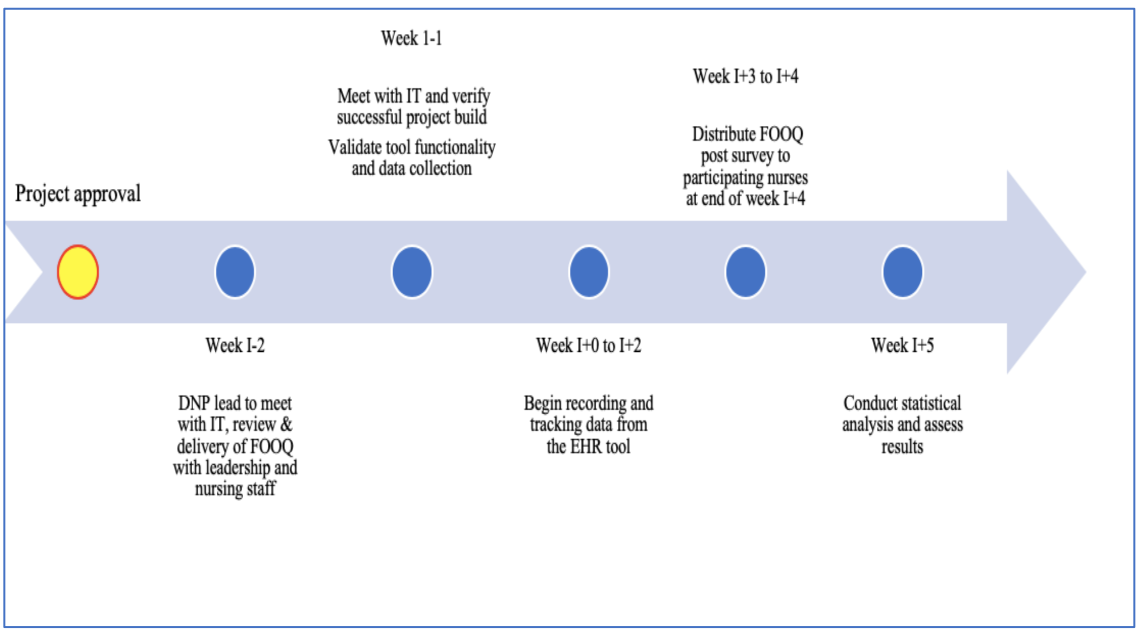


***Figure 2*. Graphical Representation of Project Timeline**

Ethics/Human Subjects Protection

Although quality improvement interventions and corresponding survey-based studies to evaluate efficacy are typically exempt from IRB approval, in this case, the participating facility required all improvement projects to be vetted by an internal review board committee. The IRB required all projects to obtain approval from the department manager first. Approvals from the local practice site quality improvement department, bone health department, and the nursing leadership department, were also required. This was followed by approvals from the regional quality improvement department, regional nursing leadership and the regional bone health departments. After obtaining the required local and regional approvals, the IRB application was then submitted and subsequently approved and is located in Appendix F. The requirement to obtain informed consent was waived by the IRB based on the determinations that the research involves no more than minimal risk to the subjects and the research could not practicably be carried out without the requested waiver. The IRB also waived the requirement that written privacy rule authorization be obtained from study participants and determined that the waiver will not adversely affect the rights and welfare of the participants. Touro University also required a project determination form from the project lead where it was also determined that the IRB approval was not necessary.

Since this project was incorporated into the continuous quality improvement structure at the participating facility, participation in the project was mandatory for the sampled population and there was no compensation for participation. Although the intervention was carefully explained to all participants, written informed consent was not required by IRB and therefore was not procured. There was no identifiable risk for participation but participants benefited from the knowledge and efficacy that they obtained in the identification of high-risk patients for osteoporosis and osteoprotective strategies.

Minimal personally identifying information (PII) was collected during the survey portion of the project so that paired samples can be analyzed during the final phase of the quality improvement. This data consisted of the last four digits of each participant's employee identification number. Once the samples were paired, all PII was removed from the data. The data was encrypted and password protected during analysis and access to the data was limited to the project lead only prior to de-identification. The information was stored in an online database on the facility's intranet and was only accessible by the project lead and secured through a password. The information will be destroyed by the project lead after a period of five years.

Plan for Analysis/Evaluation

Both the data collected from the EHR and the survey instrument was subjected to statistical analysis. For each subset of data, there was an analysis to determine the statistical significance of any increase or decrease in a variable of interest. For the nurses' pre and post training knowledge evaluation, a pre-/post- double-tailed t-test was conducted to determine the statistical significance of the training. Due to the small sample size of $n=25$ a paired t-test was appropriate to better correlate data points from before and after the interventions for each nurse. From the EHR, the raw number of osteoporosis interventions and DEXA scans were tracked. Statistical analysis of DEXA scans pre and post implementation were evaluated using Fisher's exact test with a $p<0.05$ considered statistically significant. The FOOQ questionnaire survey produced two subscales; one represented the change in percentage of the correct 20 true/false style questions between the pre- and post- surveys (paired samples) and the other the change in overall summation of answers for four Likert-like questions testing nurse participants' confidence in their knowledge of the prevention and treatment of osteoporosis pre- and post- quality improvement (paired samples). Results for each of the individual Likert-like questions were calculated as well. The samples were analyzed using a paired t-test that was used to increase the power of the analysis. The FOOQ tool was chosen for this project due to its established validity as an effective instrument that has been used successfully to evaluate osteoporosis knowledge (Fischer at el., 2018).

Implications for Nursing

An effective osteoporosis prevention initiative is critical in decreasing fragility fracture and related morbidity and mortality (Cauley, 2018). Literature review indicates a gap in practice in DEXA screenings in comparison with national guidelines (Hayawi, Graham, Tugwell, & Yousef Abdelrazeq, 2018). Nurses are in an ideal position to spearhead osteoporosis prevention campaigns and many of the measures needed to prevent bone loss and fracture are well within the scope of practice for nurses (Ailinger, Lasus, & Braun, 2003). Osteoporosis treatment includes both pharmacologic and nonpharmacologic approaches, both which have implications for nurses, including "ensuring that patients are knowledgeable about the medications that are prescribed and their correct administration to ensure that they are as effective as possible, as well as instructing them about the nonpharmacologic management of low bone mass or osteoporosis" (Smeltzer, & Qi, 2014, p. 30). Using the smart screening questionnaire, nurses were able to identify high-risk patients for osteoporosis and recommend osteoprotective strategies. According to Smeltzer & Qi (2014), the nonpharmacologic intervention includes modification of general lifestyle factors, such as a healthy diet containing calcium and vitamin D, participation in weight-bearing exercises that enhance strength and balance, avoidance of smoking and high alcohol consumption, and reducing caffeine. Such nursing implementations will benefit the communities in health improvement and translate into stronger bones, fewer fragility fractures, and higher quality of life (Sabin & Sarter, 2014).

Analysis of Results

Data analysis was completed at the project site to determine the effectiveness of the project implementation. The osteoporosis screening efficacy of participating telehealth nurses was evaluated by a pre- and post-survey which measured the two subscales. Descriptive statistics were utilized as this allowed for easy interpretation of the data set. All of the pre-test and post-test questionnaires were collected, de-identified, and checked for completeness. No identifying data was collected. Instead, each nurse used the last four digits of their employee number. The project lead neither had access to the full employee number nor to which participant paired with each set of data. This number was entered by the participating nurses on both the pre-test and post-test, allowing for anonymity but also provided the project lead with a mechanism for pairing the pre- and post- survey thus increasing the power of the study.

One subscale measured the correct responses on the FOOQ questionnaire survey and the other subscale measured the change in overall summation of answers for four Likert-like questions testing the participants' confidence in their knowledge of the prevention and treatment of osteoporosis before and after the quality improvement. Results of each question on the Likert-like section of the survey were also calculated independently. The samples were analyzed through a paired t-test that as noted above, was used to increase the power of the analysis as this test allowed for better data correlation from before and after the intervention.

There was no participant drop out between the pre- and post-surveys. Employees hired after the pre-survey was completed were excluded from the data collection. The FOOQ questionnaire was chosen for this project due to its established validity as an effective instrument, previously used successfully to evaluate osteoporosis knowledge. It has been determined to have a content validity of 0.87 and an internal consistency reliability of 0.76 (Fischer at el., 2018). The pre-survey was provided to the nurses before the osteoporosis training and the post survey two to three weeks later.

Paired samples statistics gives univariate descriptive statistics (mean, sample size, standard deviation, and standard error) for each variable entered. The data was entered into the Statistical Package for the Social Sciences (SPSS) version 25 statistical software with the results displayed in *table 1* below:

Table 1

Paired Samples Statistics Pre and Post Survey

Pair 1	Pre-Implementation Survey	13.96	25	2.761	.552
	Post-Implementation Survey	18.80	25	1.414	.283

The paired sample correlations produced a bivariate Pearson correlation coefficient with a two-tailed test of significance for each pair of variables entered. This correlation is demonstrated in *table 2* below:

Table 2

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pre_Survey & Post_Survey	25	.030	.887

The paired t-test was used to compare and measure the responses of the pre-test and post-tests that were administered three weeks apart. A P-value of less than 0.05 was deemed to be statistically significant. The paired t-test resulted in a P-value of 0.00 which is less than .05 indicating that there is a significant difference between the pre and post survey scores (see Table 3). The paired samples correlation table adds the information that pre-survey and post-survey are significantly positively correlated (r = 0.030).

Table 3

Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1 Pre-survey Post-survey	- 4.840	3.064	.613	-6.105	-3.575	-7.897	24	.000

Data analysis for the Likert-like portion of the survey was used to assess the change in confidence of participant nurses between the pre- and post-surveys. The analysis of the four individual questions and the summation of the Likert-like scores are shown in *Table 4* below:

Table 4

Likert-like survey results

Question:	Pre-Test Mean (SD)	Post-Test Mean (SD)	Mean Difference	*P value (Double Tailed T)*
Q1 I know how to appropriately screen for osteoporosis risk	4.32	6.40	2.08	0.000005.
Q2 I feel confident making interventional recommendations for persons at risk for osteoporosis	4.44	6.28	1.84	0.000006
Q3 I know when it is appropriate to recommend a DEXA scan to persons at risk for osteoporosis	5.28	6.40	1.12	0.00024
Q4 I know when to refer patients to the Healthy Bones Department for DEXA screening	5.48	6.44	0.96	0.00056
Summation	19.52	25.52	6.00	0.000002

All the questions and the summation show statistically significant improvement between the pre- and post- survey suggesting that the participating nurses felt more confident in their ability to screen and recommend interventions for osteoporosis after completing the project.

There was a question on the FOOQ that was somewhat challenging for the participants. Question 20 of the FOOQ- walking has a great effect on bone health- is false; however, all participating nurses identified this statement as true on the pre-test as shown on Table 8 below. This suggests that the nurses participating in the study may have been previously instructed that walking supports bone health, falsely correlate any cardiovascular activity as having a corresponding bone-health benefit, or do not adequately understand the complex physiology of bone stress, remodeling, and bone strength. Previous studies using the FOOQ questionnaire have found that the benefits for bone mineral density from walking is a commonly held misconception among health care professionals (Dwidmuthe et al., 2017; Park, Lee & Koo, 2017). Previous studies that have used the FOOQ questionnaire have found that most healthcare providers do not correctly answer this question (Park, Lee & Koo, 2017).

Although walking is a beneficial exercise, the 2000 NIH osteoporosis consensus conference determined that among exercise, only resistance and high-impact activities have been indicated to contribute to establishment of high peak bone mass and simply walking is not enough to improve bone health (Dwidmuthe et al., 2017; Park, Lee & Koo, 2017). Even after the training, the post-survey still revealed some nurses still had trouble answering this question; 32% still answered incorrectly. The results for the "walking is a beneficial exercise" question are shown in Table 8 and 9 below:

Table 8

Responses from the Question Effects of Walking on Bone Health Pre-Survey

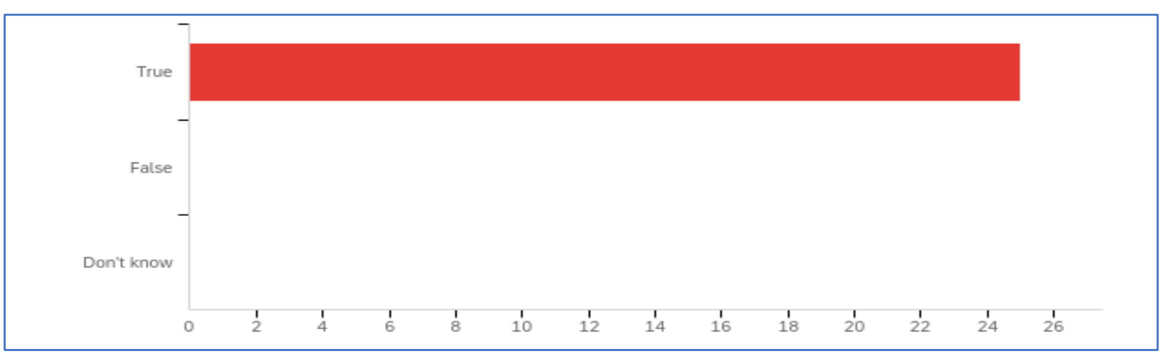
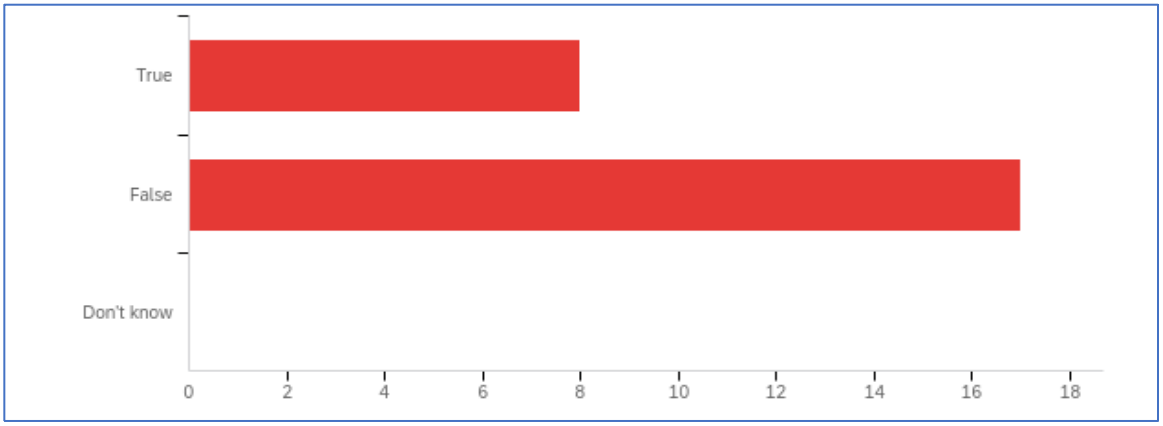


Table 9

Responses from the Question Effects of Walking on Bone Health Post-Survey



DEXA Analysis

The Telehealth department supports family and internal medicine providers who oversee patients in six different medical offices. EHR DEXA ordering data was analyzed from a large sample size of close to 30,000 women over the age of 50. The practice site has a bone health department that promotes healthy bones as part of their proactive and preventative care program. The healthy bones program uses a systematic approach to address osteoporosis and fragility fracture care gaps, utilizing information technology and care managers to identify, risk stratify, and treat at-risk patients. Subsequent tracking of identified patients with care gaps suggested that this program was effective, with a reported 40% reduction in fragility fractures (Dell, 2011).

The healthy bones proactive care sub-routine creates an alert for providers for patients aged 65 and older that a DEXA scan is due. When a patient is admitted to the hospital with a fragility fracture, an alert is also created notifying the healthy bones department so they can follow up with the patient and order a DEXA scan. Likely due to this established protocol, data analysis revealed more than 94 % of women aged 65 and older already had a baseline DEXA on record.

In comparison, less than 20% of women aged 50-64 had a previous DEXA scan on file, suggesting that women under 65 were not being adequately screened for osteoporosis risk factors to determine if DEXA screening is warranted or if they were, there was no mechanism to easily alert the healthy bones department to follow up with a patient found to be high-risk. Even though the project site DEXA ordering practice follows federal recommendations for screening for women > 65, there is no consensus for when to initiate DEXA screening for women younger than 65. The weekly DEXA orders are shown on Tables 10, 11, 12 and 13 for both age categories for the pre and post-implementation periods.

Table 10

DEXA Orders for Women Over 65

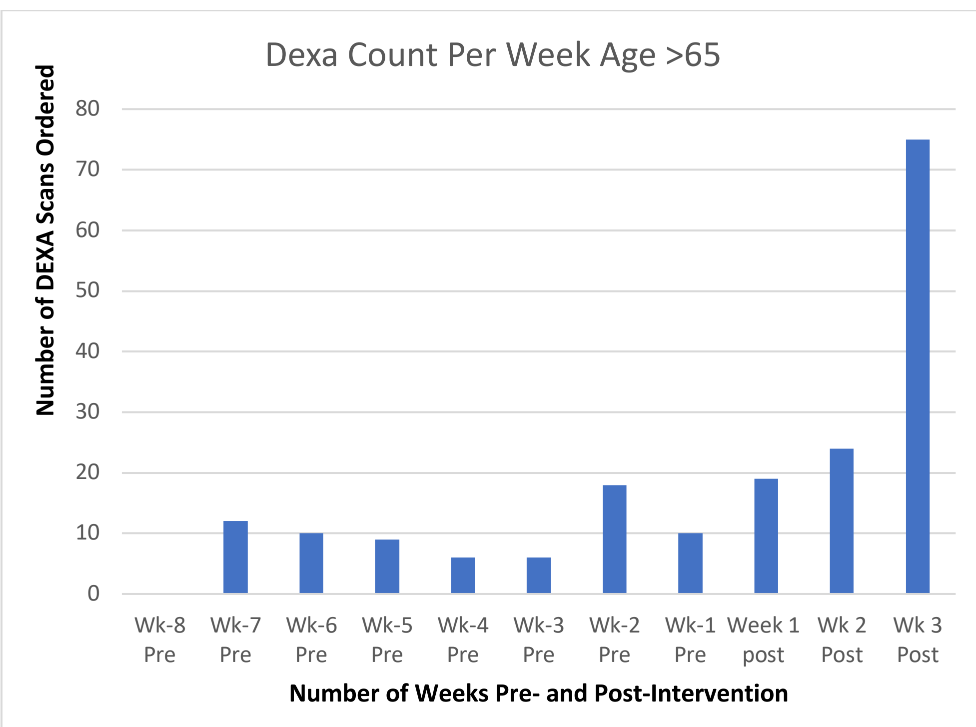
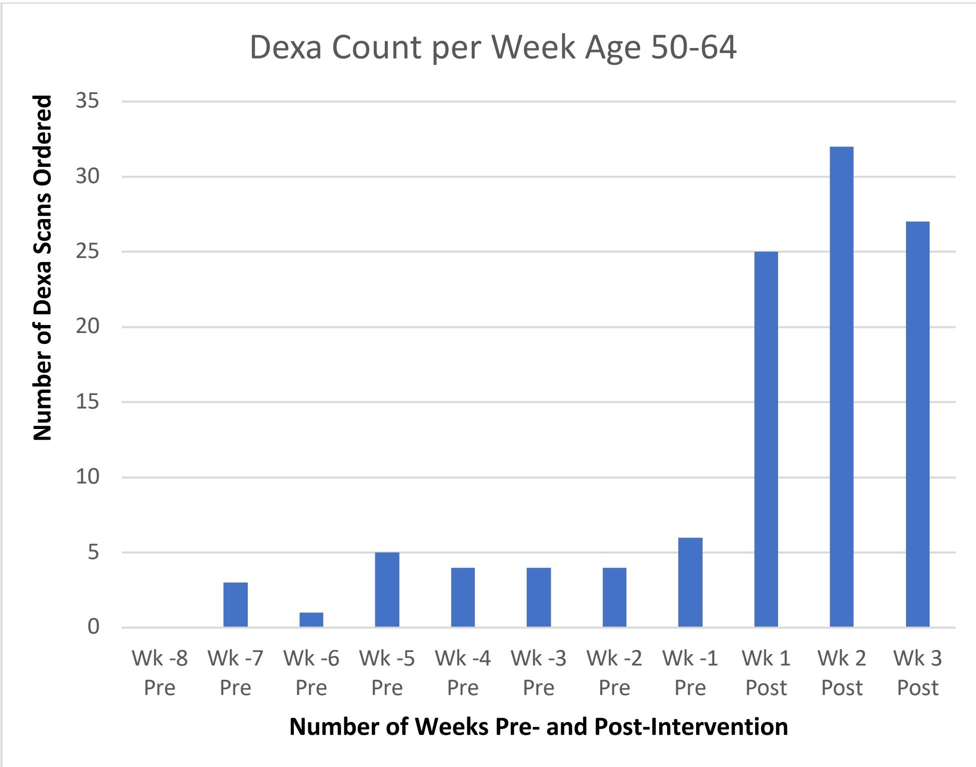


Table 11

DEXA Orders for Women aged 50-64



The NOF, American Association of Clinical Endocrinologists, and American College of Endocrinologists recommend that all postmenopausal women over 50 years be assessed for risk factors for osteoporosis to determine the need for either BMD testing and vertebral imaging. The recommendation by the U.S. Preventive Services Task Force (USPSTF) is that all women older than 65 years of age and men older than 70 years of age undergo BMD testing (Doyle et al., 2019). The lack of screening for women under 65 revealed a gap in practice since the screening recommendations are likely not followed at the bedside as primary care providers do not always have the time to adequately screen for osteoporosis risk factors and resulting in a low rate of DEXA scans for this patient demographic.

Table 12

Weekly DEXA orders for women ages 65 or more

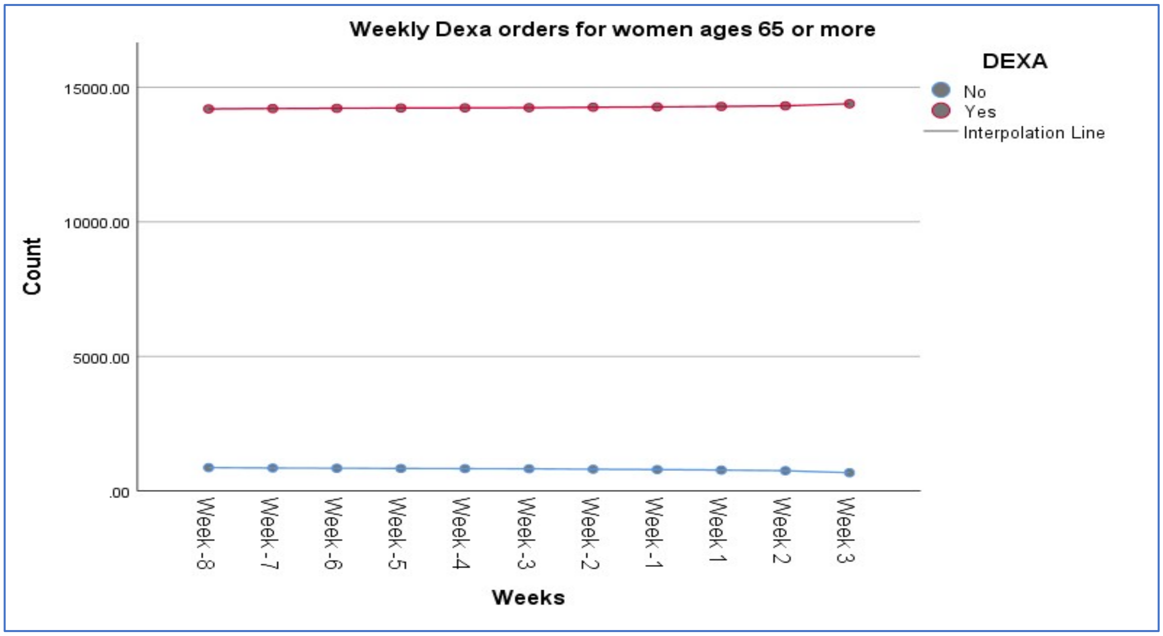


Table 13

DEXA orders for women aged 50-64

Data analysis for the EHR monitoring of DEXA scans was done using the Fisher's exact test which has a statistical significance set at $p < 0.05$ as shown on Table 14 and Table 15. The Fisher's Exact Test of independence is a statistical test used to compare two nominal variables and to find out if proportions for one nominal variable are different among values of the other nominal variable.

Table 14

DEXA Columns Pre and Post-Implementation Women >65

DEXA count for Women > 65	Pre-Implementation	Post-Implementation	Total
No DEXA	797	679	1476
Yes DEXA	14268	14386	28654
Total	15065	15065	30130

The Fisher's exact text has a statistical significance set at $p < 0.05$. The P value for the DEXA count of women over 65 was 0.0017827.

Fisher's Exact Test

P-Value
0.0017827

The p-value of 0.0017827 is less than the level of significance suggesting that the proportions of DEXA are not independent of the implementation for women age more than 65 and there is an association between the categories of DEXA and the categories of the project implementation. The null hypothesis is rejected. The data suggests a significant correlation between the intervention and the ordering of additional DEXA scans in this patient demographic.

Table 15

DEXA Columns Pre and Post-Implementation Women 50-64

DEXA count for Women 50-64	Pre-Implementation	Post-Implementation	Total
No DEXA	11981	11904	23885
Yes DEXA	2895	2979	5874
Total	14876	14883	29759

Fisher's Exact Test

P-Value
0.232388

The data analysis of women between the ages of 50-64 has a value of P-0.232388. Since this p-value is not less than 0.05, we do not reject the null hypothesis and do not have sufficient evidence to say for certain that there is a significant association between DEXA and the implementation of the intervention for women age under 55-64.

Discussion

The bone health quality improvement project was designed to increase the knowledge and efficacy of osteoporosis screening among telehealth nurses through the use of a smart screening questionnaire and subsequently evaluate the effects of enhanced screening on DEXA orders. The intention of the project was to increase the ability of participating telehealth nurses to identify post-menopausal women with specific risk factors indicating that they might benefit from bone mineral density screening via DEXA, the gold standard for establishing an osteoporosis diagnosis (Lewiecki, 2020). Analysis of the educational intervention indicated that the osteoporosis screening quality improvement was associated with statistically significant improvements in both knowledge and self-evaluated efficacy on pre- and post-test surveys as demonstrated by a paired t-test result of a p-value of 0.00, less than the selected 0.05 threshold selected to measure significance. Likewise, the participating nurses' opinions of their ability to properly assess and recommend interventions for osteoporosis showed improvement as measured by an increase in Likert-like survey scores. All four questions and the summed total of the questions improved, each with a double-tailed t-test p value of < 0.05 indicating statistical significance.

Comparison of the pre- and post-intervention DEXA screening rates for women under the age of 65 however indicated no statistically significant relationship between the intervention and rates of DEXA scans ordered for this demographic. The intervention therefore was not correlated with a change in DEXA scan ordering behavior as demonstrated by a Fisher's exact test p-value of 0.232388, above the selected 0.05 threshold for significance. This outcome was problematic since the 50-65 years old post-menopausal demographic was identified as the cohort with the largest practice gap in DEXA ordering prior to the intervention and remained so after the intervention. However, the lack of improvement in DEXA ordering for women under the age of 65 may not be related to a specific failure in project design or execution but rather a consequence of a gap in osteoporosis diagnostic/preventative practice.

Data analysis of DEXA ordering at the practice site is consistent with other studies that reported similar difficulties in the frequency of ordering scans for women between the ages of 50-65 (Brander, 2017). As noted by Brander (2017), osteoporosis screening in this demographic creates a dilemma for providers since there is not yet a consensus on when DEXA screening for women less than 65 years of age may be appropriate or beneficial. With the onset of menopause around the age of 50, bone density degradation mediated by the reduction of circulating estrogen begins before the age at which DEXA scans are typically recommended (Jaganjac et al., 2017). As a result, although most bone density loss occurs between the ages of 51 and 75 year of age, DEXA screening during the first 14 years post-menopause has not been specifically recommended nor has it been found ineffective (Jaganjac et al., 2017). According to Gourlay, Overman, and Ensrud (2015) in fact, the specific ages at which providers should start and stop DEXA screening are poorly supported by high-quality research at best and entirely unknown at worst. Nevertheless, despite this practice limitation, the literature indicates that osteoporosis screening with DEXA scanning is an important strategy for identifying postmenopausal women who are at risk for fractures. Thus, although osteoporosis is an age-related condition and risk factors generally increase with age, it seems imperative that guidelines be developed for adequately screening younger patients to identify high-risk women who would benefit from early DEXA scanning (Petrella & Jones, 2006). Since osteoporosis is a progressive disorder, early intervention may be beneficial for some patients (Pretrella & Jones, 2006).

Interestingly and somewhat paradoxically considering the findings in this study and those that preceded it, DEXA screening was cited as one of the overused diagnostic radiology procedures for osteoporosis by the Choosing Wisely initiative (Lasser et al., 2016). The Choosing Wisely initiative disseminates peer-reviewed information on overused services in an effort to decrease costs, and offers a framework for physicians to guide their practice's screening decisions (Lasser et al., 2016). The initiative offered clinical recommendations for DEXA screening for women under 65 who have certain risk factors such as hypothyroidism, low BMI, current smoker, and osteopenia although it is unknown as to what imaging modality, if not a DEXA scan, would confirm osteopenia in a patient thus limiting the utility of this recommendation (Lasser et al., 2016). To avoid inappropriate DEXA ordering as per the Choosing Wisely initiative, it is imperative to carefully screen for osteoporosis risk factors before ordering DEXA scans for women less than 65. Taken together, the lack of high-quality evidence guiding DEXA scan use for women under 65 and the suggestion that the procedure is both over-ordered and yet sometimes valuable simply highlights the need for further study. Telenurses and traditional intake personnel seem best positioned to screen for osteoporosis risk factors and recommend DEXA scanning when appropriate, but studies completed by Dharmik et al. in 2018 revealed widespread gaps in practice in relation to osteoporosis prevention strategies and osteoporosis education. Their findings highlighted the general need for multidisciplinary efforts to focus on all stages of osteoporosis management: A specific and data-supported screening methodology resulting in appropriate DEXA ordering in all patient demographics is foundational for any such effort. A study completed by Thomas et al. (2003) argued that without a screening strategy, indiscriminate ordering of DEXA scanning would result in costly and unnecessary procedures for women who based on risk factors were unlikely to require intervention. Recent research in fact, indicated that assessing risk factors for fracture in addition to or even without DEXA is a far more effective strategy than DEXA scanning alone (Brander, 2017). Nurses are in an ideal position to spearhead osteoporosis prevention campaigns and many of the measures needed to prevent bone loss and fracture are well within the scope of practice for nurses (Ailinger, Lasus, & Braun, 2003). Thus, although this intervention did not successfully demonstrate that additional education leads to changes in DEXA scan ordering, the improvement in both actual and perceived knowledge suggests that when combined with better practice recommendations, quality improvements of this kind may support more effective osteoporosis screening in the future.

Limitations

This project was implemented against the backdrop of the Covid19 pandemic, making the implementation process quite challenging. Due to the CDC guidelines advising vulnerable populations to shelter at home and avoid unnecessary procedures, there was notable resistance to DEXA scanning, as many women chose to defer the diagnostic test for a future time when the risk of Covid-19 infection might be reduced (Coimbra, Edwards, Coimbra, & Tabuenca, 2020). Also due to the pandemic, the Telehealth department was encountering unusually heavy volumes of messages and emails, which created a time barrier for nurses to effectively screen for osteoporosis risk factors. Other limitations included the use of a non-random sampling plan where only the Telehealth nurses at a single location were able to participate in the project, thus increasing the risk of selection bias. Another limitation was the inability to measure the effectiveness of the osteoprotective teaching and compliance of those who only received the educational component to reduce risk factors (Gardner et al., 2005).

Dissemination

The plan for dissemination of the project results includes sharing with the DNP program faculty and students during the DNP student presentation at Touro University.

The project will also be submitted for review and subsequent presentation at the Doctorate of Nursing Conference with the goal of eventual publication on the DNP project repository of the doctorate of nursing practice website. The manuscript will also be submitted to the International Journal of Orthopedic and Trauma Nursing for peer review and publication. Further dissemination will depend in part on the success of initial efforts to publish the results of this project; additional audiences may be sought regardless of the outcome of early submissions.

Sustainability

Early screening for osteoporotic risk factors is imperative and guides decision-making for DEXA indication based on risk factors and can eliminate fragility fractures. Thus, continuation of the project is imperative to further evaluate the use of smart questionnaires providing nurses an opportunity to discuss osteoprotective behaviors with patients, and measure the outcomes of both the use of such questionnaires and the educational programs supporting their use. The project site already had a bone health department that monitors patients' post-fragility fractures or after 65 years old, but telehealth nurses can complement the bone health department by the continuous use of the smart questionnaire to identify high-risk patients who are less than 65 years old, closing a gap in osteoporosis screening. Osteoporosis screening has the potential to identify high-risk patients for screening and preventative measures initiated thus decreasing the risk of fragility fractures, potentially saving healthcare organizations thousands of dollars related to fragility fracture hospitalization and related treatment.

Conclusion

As a result of an aging population, age-related conditions such as osteoporosis are projected to increase in prevalence with an increase in associated morbidity and mortality over the next decade. Like many chronic diseases such as hypertension, osteoporosis is a silent condition yet blood pressure is routinely screened at nearly every patient contact point; osteoporosis less so. The Affordable Care Act of 2010 included goals designed to shift the focus of healthcare from the treatment of disease to the prevention of disease before it occurs. Nurses have more patient contact than any other healthcare discipline, and are therefore in a unique position to implement evidence-based screening and interventions designed to protect patients from preventable illnesses. Thus, measures should be taken to expand nurses' knowledge and efficacy in osteoporosis screening due to their unique position in the healthcare continuum (Smeltzer, & Qi, 2014).

Strategies for osteoporosis prevention are both cost-effective, increase efficacy, and promote healthy bones. These strategies include the identification and modification of osteoporosis risk factors such as nutritional deficiencies, alcohol use, sedentary lifestyle, and social habits of smoking. None of the disease modifying behaviors move beyond the scope of practice for nurses of all educational levels, and thus there is little practical concern that making evidence-based recommendations to at-risk patients is anything but a logical extension of current nursing practice. The FOOQ smart questionnaire is a great tool for teaching osteoporosis risk assessment and early identification of high-risk post-menopausal women under 65 for DEXA indication and screening, and for providing recommendations of preventative behavioral modifications. Both the audience and the tool fit the task well: Nurses using the FOOQ may be able to make a meaningful contribution to the prevention of osteoporosis in at-risk patients and thus reduce the morbidity and mortality associated with this condition.

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Appendix A

Osteoporosis Screening Smart Questionnaire

(Only for use with female patients over 50 years old)
1. Age, gender, race, height & weight (auto-populated in health connect)
2. Has the patient had a Bone Density Scans? {YES NO}
3. Last Vitamin D within normal limits {YES NO}
4. Dietary calcium and/or Vitamin D? {YES NO}
5. Falls within the last year? {YES NO}
6. History of fracture? {YES NO}
7. Menopausal or post-menopausal? {YES NO}
8. Use of oral corticosteroid therapy for more than three months? {YES NO}
9. Family history of fragility fracture or diagnosed osteoporosis {YES NO}
10. Current cigarette smoking {YES NO}
11. Older than 65 years old and never had a DEXA scan? {YES NO}
12. Regular weight bearing physical exercise? (>30 minutes of activity weekly) {YES NO}
13. Alcohol Consumption {YES NO}
14. Osteoporosis Interventions {YES NO}

Appendix B

Osteoporosis Intervention Matrix

(Only for use with female patients over 50 years old)
Vitamin D
IF >50 *and* no Vitamin D screen on file *then* pend Vitamin D lab order for PCP's approval
IF >50 *but* <65 *and* abnormal low Vitamin D screen on file *and* supplementation ordered NO intervention
IF >50 *and* abnormal low Vitamin D screen on file *and* no supplementation ordered *then* pend order for supplementation
IF >50 *and* normal Vitamin D screen on file *and* on supplementation *then* NO intervention
DEXA Scan
IF>50 and postmenopausal and NO DEXA scan on file, then refer to Healthy Bone for DEXA Screening
IF >55 with history of fragility fractures and NO DEXA scan on file, then refer to Healthy Bone for DEXA screening
IF 65> *and* normal DEXA scan on file (*T≥-1) then* NO additional scan recommended
IF 65> *and* abnormal DEXA scan on file (*T≤-1*) *then* refer for Healthy Bones Department for additional scans and/or medical treatment
IF >65 *and* NO DEXA scan on file *then* refer to Healthy Bones Department for DEXA screening

Appendix C

Osteoporosis QI Project FOOQ Pre-Test

Start of Block: Opening Statement

Q23 Thank you for your participation in this quality improvement. Collection of data before and after the initiative will help evaluate the efficacy of the program. All personally identifying data will be used to pair survey samples and will be deleted upon completion of data analysis. Results of this quality improvement will be made available upon request.

End of Block: Opening Statement

Start of Block: Demographic Data

Q1 Please select your age range below:

○ 20-29 (1)

○ 30-39 (2)

○ 40-49 (3)

○ 50-59 (4)

○ 60+ (5)

Q2 Please select the gender with which you most identify below:

○ Male (1)

○ Female (2)

○ Non-binary (3)

○ Prefer not to answer (4)

Q3 Professional licensure:

- ◯ LVN (1)
- ◯ RN (2)

Q4 Highest level of education:

- ◯ Diploma (1)
- ◯ BSN (2)
- ◯ MSN (3)
- ◯ APRN (4)

Q5 Last four digits of employee number:

____

End of Block: Demographic Data

Facts on Osteoporosis Quiz (FOOQ) quiz

Question	True	False	Don't know
1. Physical activity increases the risk of osteoporosis.			
2. High-impact exercise (weight training) improves bone health.			
3. Most people gain bone mass after 30 years of age.			
4. Lower weight women have osteoporosis more than heavy women.			

5. Alcoholism is not linked to the occurrence of osteoporosis.			
6. The most important time to build bone strength is between 9 and 17 years of age.			
7. Normally, bone loss speeds up after menopause.			
8. High caffeine combined with low calcium intake increases the risk of osteoporosis.			
9. There are many ways to prevent osteoporosis.			
10. Without preventive measures, 20% of women older than 50 years will have a fracture due to osteoporosis in their lifetime.			
11. There are treatments for osteoporosis after it develops.			
12. A lifetime of low intake of calcium and vitamin D does not increase the risk of osteoporosis.			
13. Smoking does not increase the risk of osteoporosis.			
14. Walking has a great effect on bone health.			
15. After menopause, women not on estrogen need about 1,500 mg of calcium (for example, 5 glasses of milk) daily.			

16. Osteoporosis affects men and women.			
17. Early menopause is not a risk factor for osteoporosis.			
18. Replacing hormones after menopause cannot slow down bone loss.			
19. Children 9 to 17 years of age get enough calcium from one glass of milk each day to prevent osteoporosis.			
20. Family history of osteoporosis is not a risk factor for osteoporosis.			

Q21 For the following statements, indicate your level of agreement by selecting the appropriate circle:

	Strongly agree (1)	Agree (2)	Somewhat agree (3)	Neither agree nor disagree (4)	Somewhat disagree (5)	Disagree (6)	Strongly disagree (7)
I know how to appropriately screen for osteoporosis risk (1)	○	○	○	○	○	○	○
I feel confident making interventional recommendations for persons at risk for osteoporosis (2)	○	○	○	○	○	○	○
I know when it is appropriate to recommend a DEXA scan to persons at risk for osteoporosis (3)	○	○	○	○	○	○	○
I know when to refer patients to the Healthy Bones Department for DEXA screening (4)	○	○	○	○	○	○	○

End of Block: Opinion

Appendix D

Practice site approval letter

KAISER PERMANENTE

December 11, 2019

To Whom it May Concern

This letter is to confirm that Millicent Mucheru, has been granted permission to conduct a DNP project in the Telemedicine Department where I am the manager. There is a clinical affiliation agreement on file between Kaiser and Touro University Nevada. Millicent has also been cleared by our Education Department having passed her criminal background and drug screen. I can be reached at my office on 323 857 2656 if you have any questions and/or concerns.

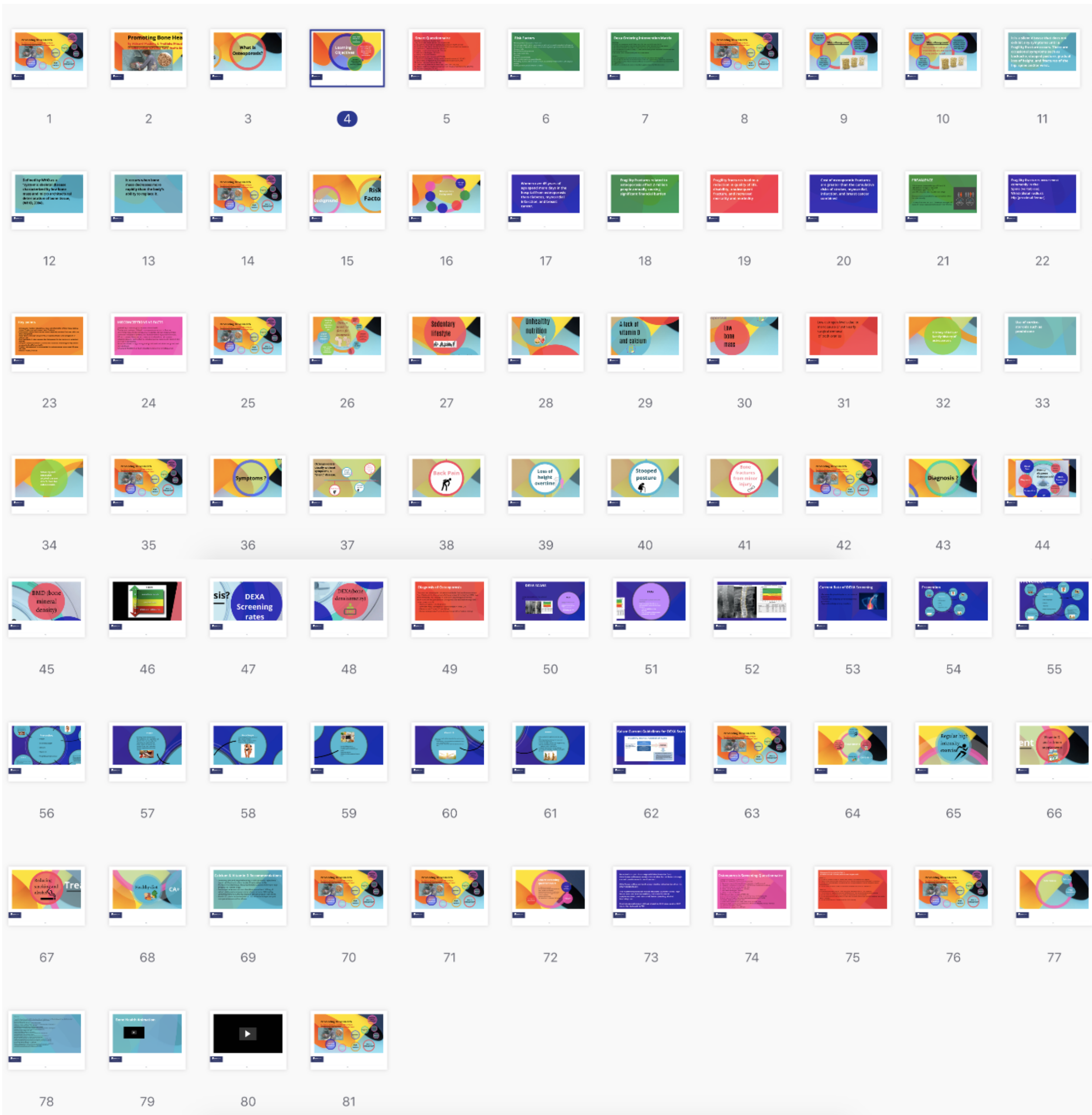
Sincerely,

P Rajani

Pratiksha Athwal-Rajani, MBA, BSN, RN
Manager Ambulatory Care Dept RN/Improvement Advisor
Kaiser Permanente
SCPMG West Los Angeles Medical Offices
6041 Cadillac Ave
Los Angeles, CA 90034
323 857 2656 (office)
8 390 2656 (tie-line)

Appendix E

Osteoporosis Training Presentation



Appendix F

IRB approval letter

KAISER PERMANENTE®

Institutional Review Board
Kaiser Permanente Southern California

April 10, 2020

KPSC Principal Investigator(s)
Millicent Mucheru, KPSC - Nursing Administration

KPSC Co-Investigator(s)
None

Study Title: Bone Health Initiative in Telemedicine Department (#12405)

On **04/10/2020**, a subcommittee of the Kaiser Permanente Southern California (KPSC) Institutional Review Board (IRB) reviewed and approved your new study.

In accordance with the requirements for research activities that present no more than minimal risk to subjects set forth in 45 CFR 46.110 the study referenced above qualified for expedited review under the following research category:

- Category 5: Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis)
- Category 7: Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies

Study Document(s):

Data Abstraction Sheet Template	01/31/2020
Appendix C-Pre Test	03/31/2020
Appendix A-Screening Questionnaire	03/31/2020

In accordance with 45CFR 46.116, informed consent was waived by the IRB based on the following determination(s):

- The research involves no more than minimal risk to the subjects;
- The research could not practicably be carried out without the requested waiver or alteration;
- If the research involves using identifiable private information or identifiable biospecimens, the research could not practicably be carried out without using such information or biospecimens in an identifiable format;
- The waiver or alteration will not adversely affect the rights and welfare of the subjects; and
- Whenever appropriate, the subjects or legally authorized representatives will be provided with additional pertinent information after participation.

The requirement that written Privacy Rule authorization be obtained from study participants was waived.

The KPSC Principal Investigator (PI) is required to:

- Review the document entitled HIPAA Privacy Rule Instructions for Researchers available at http://irb.kp-scalresearch.org/5/HIPPA_Privacy_Rule_Instructions_for_Researchers.pdf
- Submit a complete final closure report of research activities.

And if applicable,

- Submit for IRB review, modifications to the study or any IRB-approved study document(s) before they are implemented **except** when necessary to eliminate apparent immediate hazards to one or more subjects. If you determine that an immediate modification is critical to eliminate hazards to one or more subjects, you must notify the IRB within five business days of having carried out such changes to your study.
- Submit Unanticipated Serious Adverse Event report(s) according to IRB policies and procedures and consistent with federal regulations.
- Submit Protocol Violation report(s) and other Unanticipated Problem Reports according to IRB policies and procedures and consistent with federal regulations.

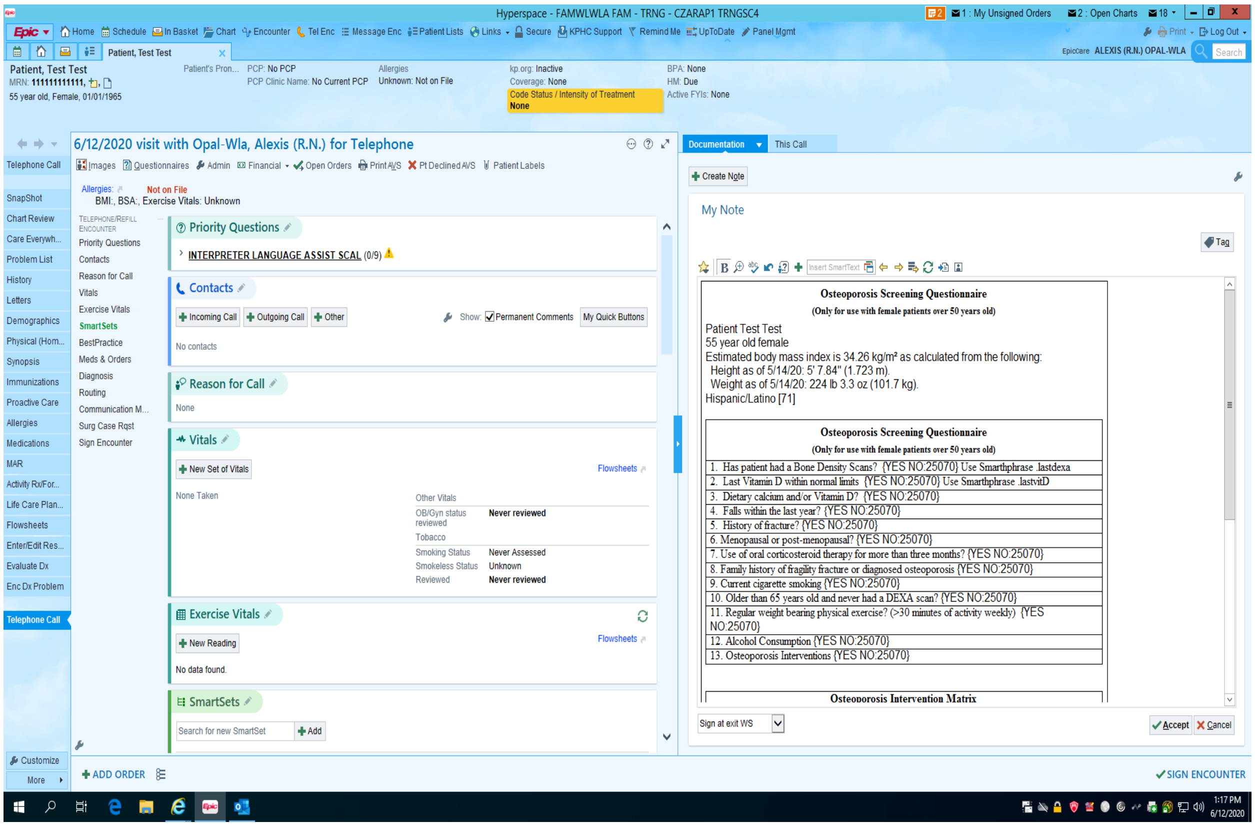
Sincerely,

Signature applied by Isabel M Sanchez on
04/10/2020 12:40:40 PM PDT

Armida Ayala, MHA, PhD
Director

Appendix G

Screenshot of EHR smart questionnaire



Appendix H

Screenshot of EHR smart questionnaire