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MySleep101©: An Educational Mobile Medical Application for Sleep Health in Primary Care

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DEDICATION

First of all, I would like to thank God for being who He is in my life, making provision and providing the vision. I would like to dedicate this quality improvement project to my family particularly my dad, Ira Brown and my husband, Patrick Cook and my closest friend, Heather for constantly encouraging me and being my cheerleaders. You prayed for me, wiped my tears and listened to my whining throughout this journey. I would not have made it without either of you! God bless you above every expectation you have for your life!

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ABSTRACT

Insufficient sleep has emerged over the past few decades as a public health concern. As little as 1 to 2 hours of sleep loss can produce extreme fatigue and physiological drives similar to thirst and/or hunger which increases the risk of motor vehicle accidents, work related mistakes and injuries. Sleep restriction whether voluntary or involuntary has produced a culture of chronic sleep deprivation that can be seen throughout the population. Chronic lack of quality sleep has been shown to adversely affect cardiovascular health, cognitive function, memory, immune responses and hormonal regulation among other homeostatic functions. Sleep disorders represent the cause for a majority of involuntary sleep loss. The Centers for Disease Control (2011) estimates that between 40 and 70 million Americans suffer from sleep disorders.

Though sleep disorders and insufficient sleep are prevalent, the assessment of sleep within the primary care setting is often unaddressed. Sorcher (2008) discussed lack of comfort, knowledge, time constraints and reimbursement as deterrents for assessing sleep. This project was developed to evaluate the impact of technology in the form of an educational mobile application in the assessment and documentation of sleep health in a primary care setting.

The primary care providers, one physician and one nurse practitioner, at an employee onsite health center in Lexington, SC were asked to download and review the sleep related educational mobile application, MySleep101©. The clinicians sleep knowledge was assessed using the ASKME Survey and the scores were compared in the pre and post intervention periods. Overall sleep knowledge was increased by both practitioners though this did not fully translate to documentation. Sleep was irregularly assessed in both pre- and post-intervention periods however there was a slight increase in documentation of sleep quality by the nurse practitioner and sleep hygiene by the physician in the post-intervention period. The need for sleep health assessment is well documented in the literature though the use of this modality did not produce consistent documentation. It is recommended that barriers be assessed in the health care setting before actual technology implementation.

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CHAPTER 1

Introduction

Quality sleep is essential to health and well-being. It has been defined as a state of reduced consciousness and response to external stimuli that enables the body to enhance mental performance, combat chronic diseases, improve immunity, repair muscles, and regulate hormones (Kryger, Roth, and Dement, 2011). The National Sleep Foundation (2011b) reported that peoples' daily individual sleep needs vary from seven to nine hours for adults and up to eighteen hours for younger children (NSF, 2011a). During infancy and early childhood, humans need the most sleep at between sixteen to twenty two hours per day (NIH, 2013). Teenagers need roughly nine hours of sleep while the average adult needs seven to eight hours for restorative effects (NIH, 2013). Advancing age produces lighter sleep at shorter intervals (NIH, 2013). The amount of sleep needed by a person increases depending on the sleep deficit in which that person is operating and that physiological sleep drive is directly impacted by external and internal challenges such as infections, acute stress and other factors (NIH, 2013; Working Group, 1997). Sleep patterns and disorders are typically inadequately assessed in primary care, even though evidence shows that the cost of poor sleep patterns and sleep disorders impacts well-being, work productivity, driving habits, and academic performance. The goal of this project is to improve the assessment and management of sleep disorders in

primary care settings by primary care providers. The project involves the providers using mobile devices in the assessment and management of sleep disorders.

1.1 Background

The cyclic function of sleep is organized into patterns identified as NREM (non-rapid eye movement) and REM (rapid eye movement), further defined by stages one through three (NSF, 2011c). A number of factors dictate the amount of time spent in each phase of sleep (NIH, 2013). The first phase of sleep, NREM is divided into three asynchronous stages along one measurement axis on the electroencephalogram (EEG). Waveforms can be appreciated on the EEG that parallel the depth of sleep with arousal thresholds generally lowest in stage one or light sleep. Most people spend a majority of their time in stage two sleep which is slightly deeper than stage one but still arousable. Stage three of sleep is called delta sleep, slow wave sleep or deep sleep. REM sleep is defined by EEG activation, muscle atonia, and episodic burst of rapid eye movement. There are no stages in REM, which is where dreaming takes place (Kryger, Roth, & Dement, 2011). It is in NREM and REM stages of sleep that the essential restorative functions take place.

For many years, scientists believed that sleep was a passive phenomenon however; ever growing research reveals its complex physical, emotional and mental restorative properties (NIH, 2013). Losing one night's sleep leads to extreme fatigue and sleepiness while chronic insufficient sleep leads to a cumulative sleep "debt" (Zee & Harsanyi, 2003; Working Group, 1997). Modest daily sleep reductions of 1 to 2 hours can lead to chronic sleepiness over time (Working Group, 1997). The lack of adequate sleep can produce a state that is analogous to physiological states of thirst and hunger

(Working Group, 1997). This state of sleepiness or the magnitude of sleepiness can be measured by the onset of sleep, length of sleep time, and duration of sleep (Working Group, 1997).

Scientific studies on animals parallel the effects of insufficient and sleep deprivation in humans. Deprivation at various stages of the sleep cycle adversely affects morbidity and mortality in rats (NIH, 2013). Immunological responses and changes to the inflammatory process can be seen over time with sleep deficiency (Ruhl, 2010). Continued sleep deprivation in humans can lead to hallucinations, mood swings, and depression (NIH, 2013). Insufficient sleep consequently hinders normal neurological functioning impeding concentration, alertness, performing complex analytical calculations, and memory (NIH, 2013). Problem sleepiness or insufficient sleep can be caused by sleep disorders, lifestyle and/or poor sleep behaviors.

The National Commission of Sleep Disorders Research has recommended that sleep inquiry be a regular part of every primary care physical examination even though there has been no formal recommendation by the US Preventive Service Task Force, American Academy of Family Physicians, American Academy of Nurse Practitioners, American Nurses Association or the Centers for Disease Control and Prevention and Research (Senthilvel, Auckley & Dasarathy, 2011). A detailed history offers the most direct approach to a patient's sleep quality and habits. A question as simple as "How is your sleep?" can start an informative dialogue with patients. Appropriate follow up questions should be related to restorative sleep and excessive daytime sleepiness (Elliott, 2001). Diagnosis of a sleep disorder or the need for further evaluation by a sleep

specialist can be further supported by corroborating subjective information with objective findings.

1.2 Description of the Clinical Problem

It is noted that since the advent of the modern light bulb, Americans get considerably less sleep than before its inception (Sorscher, 2011). Voluntary sleep restriction has produced a culture where Americans get less than 7 hours of sleep instead of 9.1 hours of sleep which was the norm prior to the lightbulb (Sorscher, 2011). The Behavioral Risk Factor Surveillance System (BRFSS) was used by the Centers for Disease Control and Prevention (CDC) to analyze data on a number of health behaviors including insufficient sleep (CDC, 2009). The BRFSS identified insufficient sleep among more non-Hispanic African Americans, adults age 24-35 and women. Women, in particular, can find themselves in a sleep deprived state due to the demands of domestic and occupational responsibilities (Ruhl, 2010). In fact, according to the BRFSS between 21.8% and 37% of the population surveyed reported insufficient sleep or poor sleep quality in the 30 days prior to the survey (CDC, 2009). A commentary by Hossain and Shapiro (2002) notes that as much as 35 to 40% of adults in the US suffered from insufficient sleep. Regional differences were also noted where those in the southeastern United States reported the most insufficient sleep (CDC, 2009). Accounting for lifestyle choices, behavior and sleep hygiene practices, obstructive sleep apnea, insomnia, restless leg syndrome or narcolepsy may still be a valid cause of insufficient sleep in many Americans.

1.3 Scope of problem

The Centers for Disease Control and Prevention (2011) reported that 40 to 70 million Americans suffer from sleep disorders. Sleep disorders can be classified into three distinct categories: 1) sleep deficiency 2) disorders of sleep and circadian rhythms and 3) environmental disruptions of circadian function (NCSDR, 2011). The International classification of Sleep Disorders has identified over ninety disorders of sleep, however, by far the most common are sleep apnea, insomnia, restless legs syndrome and narcolepsy (NIH, 2013; NCSDR, 2011).

Obstructive Sleep Apnea (OSA)

Obstructive sleep apnea (OSA) represents one of the most common sleep disorders and cause of insufficient sleep. The National Sleep Foundation (2011b) estimated that more than 18 million Americans suffer from sleep apnea. Caple (2005) defined OSA as frequent or repeated upper airway obstruction that produces a reduction in ventilation. These occurrences result in periods of apnea, cessation of breath for greater than ten seconds, and hypopnea or desaturation (Caple, 2005; CDC, 2011(a). Those with sleep apnea often have irregular sleep patterns, frequent awakenings and low night time oxygenation leading to chronic sleep loss and excessive daytime somnolence. Sleep apnea predisposes individuals to increased cardiovascular risks, metabolic disorders, cognitive impairment and daytime sleepiness which increase the risk of accidents (NCSDR, 2011). Undiagnosed or under treated OSA is a risk factor for traffic accidents (NHTSA, 1998). Healthy People 2020 set a goal to increase the proportion of people seeking care for sleep disorder breathing.

Chronic Insomnia

Chronic insomnia plagues almost 30 million people according to the National Institute of Health (2006). Insomnia is defined as the inability to fall asleep or stay asleep. Insomnia is classified as mild, moderate or severe. Mild insomnia is associated with little to no social or occupational impairment, however, symptoms of non-restorative sleep occurs almost nightly (Lee-Chiong Jr., 2003). Moderate and severe insomnia present with increasing degrees of impaired daytime and occupational functioning (Lee-Chiong Jr., 2003). Women have higher rates of insomnia than men and stress plays a part in sleep dynamics (Ruhl, 2010). Other factors such as depression, medication side effects and undiagnosed illness can be attributed to insomnia as well (Key Sleep Disorders, 2013). Studies have linked chronic insomnia to mood disorders such as depression, impaired sleep-wake cycles, impaired judgment, accidents and substance abuse (NCSDR, 2011; Lee- Chiong Jr., 2003).

Restless Leg Syndrome (RLS)

Restless leg syndrome or periodic leg movement is defined as an irresistible nocturnal urges to move the lower extremities. Acute effects are difficulty sustaining sleep and excessive daytime sleepiness (NCSDR, 2011). According to a report by the National Institutes of Health (2006), 6 million people suffered from RLS. Another study conducted by the NCSDR (2011), quotes a statistic as high as 1 in 20 people suffer from RLS.

Narcolepsy

Classified as a hypersomnia disorder, narcolepsy is defined as pervasive daytime sleepiness in combination with cataplexy, sleep paralysis and hypnagogic hallucinations (Lee-Chiong, 2003). Onset is often in mid to late adolescence but diagnosis can be delayed as long as 15 to 25 years (Unmet public health, 2006). Excessive daytime sleepiness or sleep attacks can occur with even the shortest period of inactivity culminating in an individual lapsing into brief naps of 10 minutes up to an hour (Lee-Chiong, 2003). Cataplexy, can be triggered by strong emotions such as fear, anger or surprise resulting in abrupt, temporary loss of muscle tone. Sleep paralysis is the transient loss of voluntary muscle movement at the onset of sleep or upon awakening. Hypnagogic hallucinations can be visual, auditory, tactile or kinectic. Narcolepsy is found in 0.01-0.05% of the general population and often confused with idiopathic hypersomnia (Unmet public, 2006).

Effects of Sleep Disorders

The prevalence of sleep disorders warrants attention from public and healthcare communities. In a study by Hossain and Shapiro (2002), 78% of workers reported being too tired to complete tasks and had poorer overall performances. Insufficient sleep has also been shown to negatively affect academic performance due to impaired cognitive function and inability to concentrate on intensive activities (Unmet Public Health, 2006). Despite treatment, individuals suffering from narcolepsy may experience residual sleepiness which translates to cognitive impairment, increases in accidents at home and work and possibly early death (Hossain and Shapiro, 2002).

Not only does inadequate sleep cause a cumulative negative health affect; it has been attributed to immediate adverse outcomes. Healthy People 2020 objectives have recognized healthy sleep as a major health goal thereby decreasing the incidence of sleep related vehicular deaths. Hossain and Shapiro (2002) reported that accident related costs due to sleep disorders are approximately $43.15 to $56.02 billion in 1988. The National Highway Traffic Safety Administration (NHTSA, 2011) concluded that drowsiness or daytime fatigue has been associated with 2.3-2.6 percent of all fatal automobile accidents between 2005 and 2009. It is estimated that drowsy driving accounts for up to 70% of reported property damage only accidents (NHTSA, 2011). Risk factors for drowsy driving are: being a commercial driver, shift work, being under the influence of sedating medications, alcohol consumption, drivers with undiagnosed or undertreated sleep disorders and those that do not get adequate sleep (CDC, 2014; NHTSA, 1998). Though crash site information cannot be quantified, telltale signs can often be seen to imply sleepiness as a factor. Drowsy driving related accidents often occur (1) late at night, mid-afternoon or early morning, (2) when a single vehicle leaves the road, (3) on a high speed road, (4) when the driver does not attempt to avoid the crash, and (5) with a sole driver (NHTSA, 1998). Sleep deprivation can lead to decreased reaction times, attention, deficient informational processing and reduced vigilance (NHTSA, n.d.).

Even though the economic impact of sleep disorders in the United States is not fully known some studies have provided insight. The direct costs of sleep disorders which include medical care, diagnosis and treatment were quoted in 1990 to be estimated at $15.9 billion (Hossain and Sharpiro, 2002). Most economic impact studies focus on singular dysomnias, mainly insomnia, OSA and narcolepsy. The CDC has touted a

conservative direct and indirect cost in the billions of dollars (Unmet, 2009). Those patients suffering from narcolepsy may experience symptoms so severe that full-time employment is impossible resulting in the need for permanent disability (Hossain and Shapiro, 2002).

Sleepiness at any degree effects academic performance, work related performance, number of medical errors, motor vehicle safety and every facet of life. Given these facts, education, recognition and referral are needed to address sleep problems in the general population.

1.4 Analysis of current practice

Despite the prevalence of sleep disorders and insufficient sleep, studies have confirmed that they continue to be under-recognized and under-diagnosed public health issues (NCSDR, 2011). The National Ambulatory Medical Survey (NAMS) estimates that there were over 214 million visits to non-community health centers in 2010. Even though millions of patients are seen in primary care, studies estimate that sleep disorder screenings are rarely completed in the primary care setting. In an article by Sorcher (2008) two questions were posed to understand the lack of identification of sleep disorders in primary care: Do family medicine physicians screen for inadequate sleep? What are the barriers to screening in the primary care setting? Overarching themes were reticence on the primary care provider's level due to time constraints, comfort level with sleep disorder management, resources and lack of knowledge concerning the importance of sleep issues.

It has become the unspoken mantra of health care: “Do not ask a question if you are not prepared to deal with the answer”. It is an even more relevant idea when addressing insufficient sleep in the primary care setting. The complexity of sleep related health inquiry is complicated by the time constraints and revenue generating ability of such inquiry. Average primary care visit times are approximately 15 to 30 minutes for established patients with the most pressing topics being discussed for about 5 minutes leaving 1.1 minutes for remaining topics. (Tai-Seale, McGuire & Zhang, 2007). These visits do not allow much time to tease out the nuances of sleep complaints in an efficient manner while still addressing the other more pressing concerns of the patients. Most primary care visits are for general medical exams, follow up visits, medication refills, cough and test results (NAMS, 2010). The time remaining in the visit, according to the NAMS (2010), allows providers to offer rudimentary diet, nutrition and exercise counseling, injury prevention tips, weight reduction information and growth and development benchmarks. Addressing sleep, though important, often falls by the wayside.

Papp, Penrod & Strohl, (2002) presented a survey to 580 general practitioners attempting to assess providers’ knowledge and attitudes about sleep and its physiologic effects. As expected obstructive sleep apnea was recognized by most providers as detrimental to overall health outcomes however most were not comfortable with treating or screening for other dysomnias. Over 75% of those surveyed did concede that inadequate sleep was a major health issue though only forty three percent counseled patients on the benefits of sleep and even fewer provided written literature to their

patients on sleep hygiene. As a whole, those surveyed felt that more should be done than just listen to sleep complaints.

Researchers annotated two main barriers to appropriate referral to sleep medicine specialist: lack of knowledge and perceived access barriers. After identifying patients requiring further testing by sleep medicine, providers have cited long wait times for appointments in sleep centers as well as testing costs as a barrier to referral (Sorcher, 2011). The Walla Walla study completed in 1997 showed that an intensive approach to sleep yielded an 8 fold increase in sleep referrals including sleep education, sleep equipment support, and sleep medicine support (Senthilvel, Auckley, & Dasarathy, 2011).

In a study by Senthilvel, Auckley, and Dasarathy (2011) insomnia was the most commonly asked sleep related issue seen by primary care providers. Approximately 5.7 million patients were seen for insomnia in a 2007 National Ambulatory Medical Care Survey. Gold standard treatment is cognitive behavioral therapy for insomnia however patients and primary care providers alike resort to oral medications i.e. non-benzodiazepine sedative hypnotics, benzodiazepines and other sleep aids (Moloney, Konrad and Zimmer, 2011). Even though prescription sleep aids are for short term use the shortage of qualified cognitive behavioral therapists leaves little option for primary care providers. Thus the prescriptions have increased 30 fold between the years of 1994 and 2007. This further confirms the gap between factual knowledge and appropriate clinical behaviors.

1.5 Best practices to address problem

Researchers studying knowledge and attitudes among primary care providers provided suggestions to change practice. A surprising influence of attitudes towards sleep inquiry involved the degree to which sleep medicine was integrated into medical education. In a study by Sorscher (2008), resident medical students that received didactic instruction about sleep disorders were found to be more likely to ask about sleep. Attending physicians in the study by Papp, Penrod and Strohl (2002) concurred with this assessment. Another prominent influence on medical practice was noted as articles in medical journals, CME courses, discussion with specialist, and peers while textbooks formal training and clinical practice guidelines exerted the least amount of influence on practice change (Papp, Penrod & Strohl, 2002). Sorscher (2011) recommends published guidelines that provide specific recommendations about whether and how to screen for sleep related disorders.

Office procedures can help facilitate changes as well. Review of system questions should be revamped to include a more thorough set of questions about sleep. The National Heart, Lung and Blood Institute recommends specifically tailored questions to assist primary care providers in the sleep assessment by recognizing diagnostic characteristics (Elliot, 2001). Another suggestion is to improve office tools used to screen, document and efficiently act on sleep complaints (Sorscher, 2011). Regular inquiry can be conducted by the primary care provider or a staff member who can administer sleep questionnaires before or during the vital sign assessments which can create more time for the decision making process (Bloom et al, 2009). Senthilvel, Auckley and Dasarathy (2011) suggest that offices implement standardized protocols that

utilize patient completed screening questionnaires and primary care clinical decision making.

1.6 Practice Innovation

Practice improvement recommendations can be implemented at several intervals of clinical practice from educational programming to office procedures. Technology offers a versatile approach to changing practice behavior and clinical decision making in the healthcare setting. According to a study completed by Ruder Finn (2012) there were projected to be an excess of 1 billion smartphone users and 6.9 billion mobile subscribers by late 2013 with the most utilized operating system (OS) being Android, Apple, Blackberry and Windows. It was estimated in one study that 82% of all physicians would possess smartphone technology by 2012 (Kabachinski, 2012). In 2011, 75% of physicians owned some form of Apple technology the most common being an iPhone (Ardito, 2011). With over 500 million smartphone owners projected to utilize medical mobile applications or mobile health applications, [(m)Health apps], in the year 2015, this seems the logical path to consider when attempting to positively impact practice behavior (Kabachinski, 2012).

With the exponential growth of mobile technology in the past decade from the popularity of the Blackberry in the 1990's to the release and subsequent domination of the Apple iPhone in 2007 (Kabachinski, 2012) information at the point of care changes the way medicine is being practiced. For healthcare providers, mobile health applications can offer clinical examination tools, medical references including digital textbooks, medical calculators, clinical decision support, decision trees, algorithms and any number of computer functions almost instantaneously (Franko, 2013). The iTunes medical store

available for owners of Apple technology reported the most downloaded applications as Epocrates, WebMD, Medscape, Monthly Prescribing Reference, Gray's Anatomy and Surgical Anatomy (Ardito, 2011). Widespread use of this type of technology can prove to be an asset to the healthcare providers skill set.

1.7 Statement of Purpose

The goal of this project is to improve the assessment and management of sleep health in primary care settings by primary care providers through access of an educational mobile application to increase knowledge.

1.8 P.I.C.O Model for Project Question

Melynk and Fineout-Overholt (2011) described the PICO format as a focused approach to clinical inquiry. The PICO format includes (1) Patient population, (2) Intervention, (3) Comparison intervention and (4) Outcome. The PICO for this paper:

Among primary healthcare providers, does the use of an educational sleep medicine mobile application (app) improve the assessment and management of sleep disorders in primary care settings by primary care providers? Measures will include documentation of sleep quality, hours of sleep, sleep medications, referrals if appropriate, and sleep hygiene education in adult patients who present for primary care problems and knowledge of sleep health.

1.9 Definitions

- Primary care providers – a medical healthcare practitioner that manages a person's common non emergent illnesses and conditions. Responsibilities include referral to specialists, preventive care, educating on healthy lifestyle choices and

identifying and treating common conditions. This practitioner can be a physician, physician assistant or nurse practitioner (Zieve & Eltz, 2012).

- Health mobile application (mobile app) - According to the FDA (2013), "it is a software application that can be executed on a mobile platform." It can turn be an accessory to a medical device or transform a mobile platform into a medical device.
- Adult patients- a fully grown person having reached full size and strength ages 18-64 (Free Dictionary, 2014).
- Provider choice- refers to the usual and customary approach to assessing a common medical issue, sleep history, review of systems and/or sleep questionnaire. Example: Epworth Sleepiness Scale or verbal medical history. Example: "How many hours do you sleep a night? Do you snore? Do you awaken tired? Has anyone observed you stop breathing in your sleep? Do you have high blood pressure? (Bailey & Attanasio, 2012)
- Sleep health-refers to an individual and/or a populations measurable characteristics of sleep and its effects on health outcomes not merely the absence of sleep disorders (Buysse, 2014).
- Sleep disorders- defined as any unusual sleep pattern classified into three distinct categories: 1) sleep deficiency 2) disorders of sleep and circadian rhythms 3) environmental disruptions of circadian function (NCSDR, 2011).

- Sleep quality- is defined as feeling rested or restored upon waking, the number of night time awakenings, and perception of daytime drowsiness (Harvey, Stinson, Whitaker, Moskovitz, Virk, 2008)

- Hours of sleep- defined as the time spent in reduced consciousness and response to external stimuli averaging between seven to nine hours per 24 hour cycle for the average adult. (Kryger, Roth & Dement, 2011)
- Sleep medications- an oral medication, benzodiazepines, hypnotics, sedatives, utilized to induce a calming, soothing or tranquilizing effect on the body inducing sleep (Insomnia, 2014).
- Sleep Medicine Referral- defined as the transfer of care from one clinician to a sleep medicine specialist for further work up and treatment.
- Sleep hygiene education- defined as tips and techniques to develop healthy sleep habits (Thorpy, 2003)

1.10 Assumptions

An added component to this project is the identification of the technology comfort level of healthcare providers. A survey conducted by McGowan et al (2012) hypothesized "technology usage is best predicted by a physician's attitudes toward technology, perceptions about technology's usefulness and ease of use, and individual factors such as personal innovativeness." The medium being used to introduce increased awareness and screening among PCPs is technology in the form of a mobile application; therefore technology comfort will directly impact success. The assumptions being made are that a majority of PCPs have and utilize some form of smartphone technology and use it to some degree for clinical support. During the pre-intervention process, practitioners were asked to complete a basic questionnaire concerning their personal and professional use of smartphone technology.

Tools to measure barriers to the use of mobile application technology for assessing and managing sleep disorders was not conducted among the providers for this project. However, informal discussions with providers unveiled they did not administer sleep documentation tools or questionnaires, complained of limited time for patient education, and did not use mobile applications for assessing or managing sleep disorders. A final assumption is that providers will utilize the mobile application technology since they currently use technology for personal use.

Summary

Undiagnosed and undertreated sleep disorders pose a significant health, economic and social risk. Billions of dollars are attributed directly and indirectly to insufficient sleep as it relates to health care, performance and accidents (Hossain and Shapiro, 2002). Numerous studies confirm the relationship between sleep and cognitive impairment and memory. Untreated obstructive sleep apnea is linked to hypertension, cardiovascular disease, depression, memory impairment and even sudden death (CDC, 2009). Inadequate screening and recognition of sleep health is a pervasive problem in the primary care setting. Insufficient knowledge, lack of comfort with managing sleep disorders, time constraints, minimal reimbursement and lack of resources have been noted to hinder screening and appropriate referral (Sorcher, 2008). Most major health organizations agree that there needs to be a fundamental shift in attitudes and family medicine needs to seek a greater level of engagement in the field of sleep medicine.

The National Centers on Sleep Disorder Research (2011) published goals to guide future research and practice. One goal spoke specifically to healthcare providers:

"*Goal 3 - Improve prevention, diagnosis, and treatment of sleep and circadian disorders, chronic sleep deficiency, and circadian disruption, and evaluate the resulting impact on human health."*

According to the National Center for Sleep Disorders Research (2011), many advances have been made in the recognition and description of sleep disorders, however little progress has been made in prevention strategies, innovation, personalized treatment plans and improving existing treatment. Progress can be made in a number of ways including education, utilizing technology, developing screening tools as well as developing national clinical guidelines. Clinical resources and support need to be allocated to the primary care setting to improve involvement and awareness of sleep health.

Table 1.1

PICO Table

Patient Population	Intervention	Comparison Intervention	Outcome
Primary care providers	Sleep medicine medical mobile application	Provider Choice for the assessment and management of sleep disorders	Improved documentation of assessment and management by primary care providers of sleep disorders in adult patients as measured by the documentation of: • sleep quality • hours of sleep • sleep disorder diagnoses • sleep medications • referrals if appropriate • sleep hygiene education over a 1 month period

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CHAPTER 2

Analysis of Literature

Insufficient sleep related to underdiagnosed and undertreated sleep disorders in the general population exacts a heavy toll in terms of increased costs and decreased health outcomes, which warrants public and primary care attention. It is estimated that as much as 40% of the US population suffers from poor quality sleep (Hossain & Shapiro, 2002). Chronic insufficient sleep is associated with depression, abnormal cognitive function, and impaired immunologic responses among other health issues (Ruhl, 2010; NIH, 2013). Sleep disorders are also linked to cognitive and memory impairment which translates to poor academic and work performance (Unmet, 2009). Researchers have found a positive correlation between diabetes risk, obesity and cardiovascular disease and sleep quality (CDC, 2011b). The burden of insufficient sleep does not stop with short and long term adverse health effects. Economically, the cost of insufficient sleep was estimated to be in the billions of dollars in the late 1980's and that total has certainly increased significantly since that time (Hossain & Shapiro, 2002).

Although insufficient sleep is prevalent, primary care providers continue to neglect regular screening recommendations. Time constraints, lack of knowledge, effective screening tools and attitude towards the impact of sleep have presented barriers to screening for sleep health in the primary care setting. The purpose of this research

utilization project is to compare the impact of an educational sleep medicine mobile medical application to the provider's choice for assessing sleep health and disorders in a primary care setting. Mobile medical applications can provide an easily accessible tool for primary care providers. An integral component of implementing quality improvement projects is to conduct a substantive review of literature. This chapter will detail the search process as well as analysis of the literature found to formulate evidenced based practice recommendations.

2.1 Search Process

A literature search was conducted based on the project question formulated. Multiple medical databases were reviewed for literature related to the project. The search was initiated using the Cumulative Index to Nursing and Allied Health Literature (CINAHL) Plus with Full Text, PUBMED.gov and MEDLINE (OVID) databases. Duplicate articles were identified in all databases. The Cochrane Library, Joanna Briggs Institute and The Journal of American Medical Association Network database were explored next.

Various research and medical databases were used to search a combination of the following terms: family medicine, primary care, sleep diagnosis, sleep assessment, and sleep disorders. Criteria for inclusion included peer reviewed articles, English language, published between 2005 to present date. Articles related to pharmacological intervention and mental health diagnoses were excluded. Articles were excluded that were related to pediatrics, prevalence, and chronic disease processes. Meta-analysis, research clinical trials, randomized and nonrandomized clinical trials and systematic reviews were

considered. Titles and abstracts were reviewed for relevance to the research topic. Specific sleep disorder assessment research was included to provide a more robust literature search result. The search resulted in 626 articles however only 12 non-duplicate research articles that were relevant to the topic were identified as noted in Table 2.1. The search was subsequently expanded as it became apparent that there was no current literature directly related to technology usage for identification of sleep disorders.

The same databases were queried for technology related terms: smartphone, smartphone adoption, smartphone utilization, mobile technology, educational mobile applications, handheld computers, (m) Health, professional knowledge, professional development, continuing education and clinical decision making. The same inclusion criteria applied to the technology terms. Abstracts were carefully scrutinized. Articles related to medical devices, patient utilization, and mobile technology as communication devices and mobile devices as medical device monitors were excluded. Research focusing on the use of mobile technology in the educational setting was also excluded. Articles were sought that focused on adoption of mobile technology as it relates to patterns of usage, sleep education, effect on practice behaviors, and clinical decisions. A total of 16 articles were identified.

2.2 Levels of Evidence

The Scottish Intercollegiate Guidelines Network (SIGN) provides a framework for the evaluation of literature. The table below depicts the SIGN guidelines for distinguishing levels of reliability of different research.

2.3 Guidelines

The Appraisal of Guidelines for Research and Evaluation II tool (2009) uses a systematic approach to score various components of evidence based guidelines such as scope and purpose, stakeholder involvement, rigor of development, clarity of presentation, applicability and editorial independence. Areas are given a score between 1 and 7 then the scores in each given category are compiled to formulate a percentage for each (AGREE, 2009).

2.4 Literature

Randomized Controlled Clinical Trials

There were no randomized clinical trials identified that met the requirements of the PICOT for this project.

Non-randomized Controlled Clinical Trials

Grover et al. (2011) questioned whether review of systems (ROS) forms facilitated identification of sleep complaints and how often clinicians investigated those complaints. Researchers also sought to determine the prevalence of patients at high risk for obstructive sleep apnea (OSA) and how well ROS responses operated as diagnostic tools to identify OSA risk. Two practices were used during a 6 week period in this study. The combined sites produced N=249 patients, n=185 from site one and n=65 from site two. ROS forms were given to site one with 2 imbedded sleep related questions while the second site was instructed to continue with standard verbal ROS inquiry including, “Are you tired much of the time?” and “ Do you frequently have trouble sleeping?” Patient completed Berlin questionnaires were used to assess risk for OSA and were completed

along with ROS forms prior to arrival and collected at the front desk. Physicians were blinded to Berlin questionnaire responses. The patient was then seen by their medical provider.

Unfortunately, physicians infrequently documented sleep complaints or assessed associated risks. According to researchers, physician inquiry about excessive sleepiness only occurred 25% while inquiry about snoring and witnessed apnea only occurred 10% of the time. There was no documentation noted about drowsy driving. The ROS forms were significantly associated with increased documentation of sleep complaints more so than verbal inquiry (31% versus 5%, p=.03). At the first clinical site, two thirds of the patients who noted sleep complaints did not have them addressed during the visit despite answering affirmatively to the imbedded sleep questions. Furthermore, ½ of the patients that were high risk for OSA per Berlin questionnaire did positively respond to the ROS questions ($p < .0001$). Of the 36% of patients that indicated sleep issues only 11% received further evaluation. Positive responses on the ROS forms were significantly associated with increased risk for OSA confirmed by the Berlin questionnaire. The ROS form only had a sensitivity of 57% and specificity of 73%.

This study was given a SIGN rating of 1+ as it was well conducted with a low risk of bias. Physician attitudes and knowledge about OSA were recognized beforehand as a possible source of bias. Researchers administered the 18 question Obstructive Sleep Apnea Knowledge and Attitudes (OSAKA) assessment to all physicians not engaged in direct investigation. A majority, 70%, answered 13 of the 18 knowledge questions correctly. More than half of the physicians, 82%, reported that it was very important or extremely important to recognize OSA. Given the results of the OSAKA, there was a gap

between factual knowledge and appropriate clinical actions. Additionally, to offset possible bias, non-investigating physicians were not notified in advance about the project however researchers were not blinded to the individual patient's primary care physician.

Chung et al. (2008) developed a screening tool for use in the perioperative setting. Perioperative patients tend to have a higher prevalence of OSA according to researchers (Frey & Pilcher, 2003). This prevalence varies by perioperative setting. Based on the Berlin questionnaire, the STOP (Snoring, Tiredness, Observed apnea and blood Pressure) tool provided a simple 4 question tool to assess risk of OSA. Researchers used a sample of 2467 patient with 27.5% of patients considered high risk for OSA. Polysomnography (PSG) was completed on 211 of the patients screened with the STOP questionnaire. Pilot testing was completed on 34 and 177 patients were used for validation. The sensitivity was found to be 72% with the specificity found to be at 33.3%. Though the STOP questionnaire was highly sensitive alone, its sensitivity increased with the addition of data gained from the BANG assessment (BMI, Age, Neck circumference and Gender). This tool has not been used or validated in other settings.

This study was given a SIGN rating of 1+ for its low risk of bias. A possible source of bias was the fact that the one scoring polysomnography technologist was not blinded to the STOP scores, however to offset this ten randomly selected patient records were also scored by a second polysomnography technologist who was blinded to the scores of the first technologist. The scores were almost identical in both cases ($r=0.984$, $p< 0.0001$).

Chai-Coetzer et al. (2011) sought to develop and validate a simplified two-step process to identify OSA. The process consisted of a screening questionnaire followed by home sleep monitoring. Researchers modified the Berlin questionnaire, which was validated in primary care and categorizes patients as either low or high risk for OSA. A four question screening tool was developed assessing: loud snoring, waist circumference (men > 40in, women >size 16), age >50 and witnessed apnea. Following completion of the screening tools, a two channel portable monitor was used to confirm diagnosis. Researchers recruited 157 subjects between ages 25 and 70, (n=79 were the control group and n=78 as the experimental group). To minimize the confidence interval and ensure diagnostic accuracy, an "OSA enriched" patient sample was selected for portable home studies. The OSA50 tool was significantly predictive of moderate to severe OSA ($p<0.001$) using the cutoff of AHI 5 or > or = 10; 100% sensitivity, specificity of 29%.

The study's strength lies in the development of the two stage diagnostic model with comparable study groups. The validation group was similar to the experimental group ($p< 0.001$). Despite the study design, this study was given a SIGN rating of 1- for its high risk of bias as the authors reported competing interest and previously diagnosed OSA patients were deliberately used in this study to validate the tool.

The Auckland Sleep Questionnaire was being audited and validated in the research study by Arroll, Fernando, Falloon, Warman, and Goodyear-Smith (2011). This tool was developed to identify insomnia, mood disorders, OSA, and delayed sleep phase disorder in the primary care setting. A specially chosen subset of 36 primary care patients was chosen to complete the survey and be interviewed by a psychiatrist trained in sleep disorders to represent the range of patients with sleep problems. Additional validation

was completed with (N = 85) patients being seen in a private psychiatric clinic. The specially trained psychiatrist was blinded to the results of the ASQ then conducted a patient visit. The tool was found to have a sensitivity of 78% and specificity of 77% for primary insomnia.

This study was given a SIGN rating of 1- due to the very high risk of bias. Arroll et al. (2011) sought to validate a potential tool for use in the primary care setting; however, the process of selecting patients presents a threat to validity. Some subjects were specifically selected to ensure a 50% distribution of sleep disorders, thereby narrowing the confidence interval around the sensitivity and widening around the specificity. The follow up structured interview with the specially trained psychiatrist was done up to one month after completion of the survey for some of the subjects; therefore, some of the diagnoses may have changed.

Goldbach et al. (2014) compared the effects of mobile medical applications and other electronic medical resources on first year residents' clinical knowledge in a remote setting. The researchers utilized a two arm comparative study design with one arm utilizing PubMed abstracts accessed via PubMed for Handheld websites and the other arm using medical/drug reference applications. First year residents N=19 used myTouch 3G Slide HTC Android phones for the purposes of this study. The medical applications suite loaded to one arms Android phones were Medscape, 5-Minute Clinical Consults, 5 Minute Pediatric Clinical Consults, A to Z, Drug Facts, Clinical Evidence 2E, Cochrane Abstracts, Communicable Diseases, Drug Interaction Facts, Emergency Medicine Manual, Evidence-Based Medicine Guidelines, EE +POEM Archive/EE + POEM Daily, The Merck Manual, Red Book, Review of Natural Products, Taber's 21st Edition,

Skyscape including MedAlert, Archimedes, Dynamed, Outlines in Clinical Medicine, Rx Drugs, Epocrates Rx and Medscape. Both arms were tasked to complete 8 scenarios with multipart questions using only the resources assigned and not any previous knowledge. The study variables were intervention arm, resident type and question type. The grading scale used was fully correct, partially correct or fully incorrect.

This study was given a SIGN 1- due to the high risk of bias. The sample of subjects was relatively small and subject to the rural location of the residency. There were also limitations in the users' ability to effectively search the databases and network connectivity. There was a statically significant difference between those that used the PubMed website and those that used the mobile applications. The percentage of fully correct answers were higher among the study participants that used mobile apps than those that used PubMed abstracts (χ^2 =41.27, p<0.0001, 36% vs 14%). Pediatric residents followed by emergency medicine residents had the most fully correct answers using mobile apps (46% vs 11%, <p=0.0001; 52%% vs 24%, p=0.0021 respectively). Family medicine residents and internal medicine residents also showed increased fully correct answers with mobile applications (24% vs 15%, p=0.0071; 27% vs 5%, p=0.05).

With the exception of one technology related study, sleep health tools and assessments were the primary focus of the non-randomized clinical trials identified through the literature search. The study identified by Goldbach et al. (2014) showed that commercially available mobile apps improved knowledge in residents more than accessing PubMed online sources in clinical care studies. Grover et al. (2011) use of a modified Review of Systems form and Arroll et al. (2011) use of the Auckland Sleep Questionnaire were both conducted in primary care settings. In the study by Grover et al.

(2011) knowledge and attitudes concerning OSA as a health concern did not positively affect physician identification and investigation of sleep complaints. The two questions concerning sleep addressed in the ROS form were not sufficiently sensitive for sleep disorders. The preliminary results of the Auckland Sleep Questionnaire suggests that revisions and a larger patient population need to be done before it can be useful in the primary care setting. Studies by Chung et al. (2008) and Chai-Coetzer et al. (2011) sought to develop a simplified screening tool, STOP BANG, and a two-step process, OSA 50, respectively. In perioperative patients, the STOP questionnaire in conjunction with BANG assessment was highly sensitive to patients with moderate to high risk of OSA. The OSA 50 shows promise for use in the primary care setting. There is some concern about validity among the general population with unknown risk for OSA. Though researchers see the need for quick effective screening tools, none have been validated on a large scale so far to meet the current clinical need.

Systematic Reviews

Divall, Camasso-Stefinovic, and Baker (2013) conducted a systematic review evaluating research on the effect of handheld devices on clinical practice. Specifically, whether handheld device use improved clinical practice compared to the usual professional practice as well as outcomes of care. After an extensive literature search, seven articles were found to meet inclusion criteria. Five of those studies reviewed handheld devices with CDSS and guidelines, while two studies involved handheld devices as data collection tools. Statistical significance was found in three of the studies. Study groups that used handheld devices with CDSS identified more diagnoses than control groups. This systematic review was given a SIGN rating of 2+ due to its very

high quality identified several key factors that needed to be considered including wireless network infrastructures, system securities and integration. The researchers' use of a well-defined clinical question which in this case they sought to compare the impact of personal digital assistants versus the use of standard practice, i.e. review of systems checklist, on practice and care outcomes (Divall et al., 2013). The use of this question along with a comprehensive search of literature meeting the inclusion criteria produced a well-conducted study. Researchers utilized a dual independent extraction method to collect the data thereby reducing risk bias.

Mickan, Tilson, Atherton, Roberts, and Heneghan (2013) presented a scoping review of the use of handheld computers by healthcare professional. Researchers explored all aspects of clinical practice effectiveness in their review of 138 studies. Quantitative studies were identified addressing patient documentation, patient care outcomes, information acquisition and professional work patterns. Handheld devices were shown to improve clinical decision making and patient management as well as significantly reduce prescription error rates (0.23 vs 0.45; $p<.05$). Point of care access was reportedly improved with drug databases, evidenced-based guidelines and locally developed guidelines preloaded on handheld devices. According to 75% of physician users across multiple clinical settings handheld devices integrated well into clinical practice. The median patient encounter time was significantly decreased with the use handheld devices compared to paper documentation. This study was given a SIGN rating of 2- as it is a scoping review with no primary studies.

A systematic review was completed by Garrity and Elam (2006) to provide estimates of handheld device use by healthcare providers. Handheld device usage was

high however the usage varied over studies published between the years 2000-2005. Personal and organization adoption rates varied between 33% and 85%. Younger physicians under the age of 45 were found to be more likely to consider using handheld devices more so than older physicians (94% versus 84.5%). Pediatricians under the age of 30 were shown to have high rates of usage at 75%. Handheld device use was higher among family practitioners than surgical specialists (71% vs 54%). This study was given a SIGN rating of 2- as this study was well conducted and has a high risk of bias. The researchers sought to capture all of the health care related hand held device studies including surveys within the time frame. They collaborated with an information technology specialist to ensure a comprehensive search however the risk of bias was adversely effected as there were only two reviewers that determined study relevance.

Gagnon, Ngangue, and Desmartis (2015) examined m-health adoption by healthcare professionals. Literature was reviewed from 2000-2014 and 33 articles met inclusion criteria. Within the articles 179 barriers were identified to adoption of m-health technology. Researchers sought to see if m-health adoption was dependent on cost, ease of use, design, time, privacy, perceived usefulness, risk-benefit assessment and interaction with others. Some clinicians identified m-health as disruptive to the work place, hinder patient-provider interactions and could be time consuming. Organizational support presented external barriers like management support, availability and access. This study was given a SIGN rating of 1+ as it was well designed. Researchers used an exhaustive search technique covering a 14 year period and found over 4200 articles that met initial review criteria.

The systematic reviews found for this project were related to the use of handheld devices. Garg et al. (2005) and Divall, Camasso-Stefinovic, and Baker (2013) noted that handheld devices positively impacted clinical performance however more research was needed to validate this assessment. Clinical performance was shown to be improved with the use of system activated CDSS more so than clinician initiated systems (Garg et al., 2005). Handheld device use with CDSS software can improve diagnosis, patient documentation, patient care, patient outcomes, access to clinical knowledge and clinical work flow. Gagnon, Ngangue, Payne-Gagnon and Desmartis (2015) identified perceived usefulness, ease of use, design, cost, time and privacy as factors or barriers to m-health adoption among healthcare providers. PDA use among healthcare providers is varied among studies with younger medical providers embracing technology more than older providers. Researchers have found that the use of technology has outpaced research. By the time research has been conducted, a particular technology is either in practice or abandoned (Garrity & Elam, 2006).

Expert Opinion

Sixty articles were identified by Ozdalga, Ozdalga, and Ahuja (2012) to assess the use of smartphones by physicians and students in practice. These articles were divided into patient care, health applications for laypersons, communication, education, research, and physician and student reference applications. There were very few high quality studies found and much of the patient care related research is still preliminary. Research showed that mobile applications are poorly scrutinized for accuracy and rapidly evolving technology makes up to date research difficult.

Buijink, Visser, and Marshall (2013) provided a look at the use of medical applications for smartphones in practice. Though medical apps hold great potential for improving clinical practice users and regulatory bodies have many factors to consider. Authors commented that several websites provided peer reviewed commentary on some medical applications however the scientific evidence for content was not addressed. Buijink et al. (2013) suggest that physician and patient organizations develop and implement peer review systems that will lead to application development.

Behar, Roebuck, Domingos, Gederi, and Clifford (2013) reviewed sleep medicine applications for use on the smartphone. Authors determined that sleep applications were divided into three main functions: questionnaires, actigraphy and audio capabilities though none have any scientific evidence of clinical effectiveness. There are several applications that provide digital representations of the Epworth Sleepiness Scale, Berlin questionnaire and STOP BANG questionnaire. Several applications target consumers offering snore monitors using the embedded microphone of the users' smartphone and some operate as actigraphy monitors. Applications targeting healthcare professionals provide algorithms, questionnaires and processes.

Expert opinion studies provided commentary on the use of smartphones in clinical practice. The use of smartphones in medicine has not been fully researched and a majority of medical mobile applications are developed without medical professional input. There are concerns about patient confidentiality, malfunctioning clinical decision making processes, the lack of peer review processes and conflict of interest are foremost. At this time there is only professional commentary on usability and content is available for medical mobile applications. Mobile applications need to be evidence based and

updated to reflect the latest evidence based research (Buijink, Visser & Marshall, 2013; Ozdalga, Ozdalga & Ahuja, 2012).

Validated sleep questionnaires are available in a mobile platform (Behar, Roebuck, Domingos, Gederi & Clifford, 2013). International sleep health applications are abundant for use on the smartphone however use of the smartphone as a diagnostic medical device has not been validated, regulated or approved. Schwartz, Roth, Hirshkowitz, and Wright, (2009) suggested that primary care providers should incorporate a sleep history into the patient's medical history and include information from their bed partners. Utilizing self-reporting questionnaires can assist clinicians in assessing sleep habits: Epworth Sleepiness Scale, Stanford Sleepiness Scale, Karolinska Sleepiness Scale, Fatigue Severity Scale, Fatigue Questionnaire, Fatigue Impact Scale and Brief Fatigue Inventory can help providers diagnose and refer patients appropriately.

Descriptive Studies

Researchers sought to analyze the uptake and acceptance of a mobile app for the delivery of an antimicrobial prescribing policies using a mixed method, in-depth case study with pre and post intervention surveys. Charani et al. (2012) developed the Imperial Antimicrobial Prescribing Application for use in 5 teaching hospitals over 16 months. Prior to the implementation of this mobile app version, half of the participants reported that they used commercially available applications to inform their practice. Forty percent of junior physicians with smartphones downloaded the application within the first month and 100% of junior physicians within 12 months. Over 1900 sessions were accessed in the first month through the mobile app versus 221 sessions on the intranet version.

Interestingly, 71% of the clinicians involved stated that the mobile app version improved their knowledge.

Rajpaul and Acton (2015) provided a descriptive study detailing a specially designed mobile application for effective pressure ulcer education delivery. Prior to the development of this app, the hospital staff had a choice of receiving this education through classroom based training, ward-based training, or computer based training. Each presented challenges to participation, including time away from direct patient care and coordination of training times. The goal of this app was to raise awareness of pressure ulcers, correct classification, reduce complications and identify training needs. The mobile app was developed for iOS© and Android systems and provided 5 educational modules on prevention, classification, treatment, equipment and risk assessment lasting 15-20 minutes each. Each module included a post educational multiple choice quiz at the end. Two nursing home focus groups were used to provide feedback on app functionality. Researchers reported >1000 downloads of the app and an increase of avoidable pressure free days from 100 days to more than 200 days.

Yaman et al. (2015) provided a 27 item survey to 176 participants at a national family medicine conference in May 2015 to assess the use of smart phones and medical apps. The survey was subdivided into four parts: demographics, possession of mobile technology, personal thoughts on mobile apps and acceptability of mobile app use in practice. Ninety-four percent owned android devices, 34% were iOS© users, 3% owned android and iOS© devices and 0.6% owned Windows and android devices and 1.8% didn't know what their operating system was. Of those surveyed, 24.4% suggested that mobile apps were useful in clinical practice. Forty-nine percent of participants stated that

they used medical apps daily to assist with medical issues. The most used applications were those for drug references, journals, evidence-based guidelines, picture atlases, prediction rules and medical calculators.

Handheld device use among nurse practitioners was described in a survey by Stroud, Smith, and Erkel (2009). The survey sought to capture nurse practitioners use and attitudes towards personal digital assistants (PDA) in the clinical setting. A 27 item survey was developed and distributed to members of the AANP. Researchers received 126 surveys in response. The study subjects were predominantly white, middle aged, non-Hispanic, and female with master's degrees working in family or adult medicine. Overall, 64% of nurse practitioners stated that they used PDAs with drug reference programs being the most frequently installed software. Of the practitioners surveyed, 76% used PDAs five or more days per week and 98% reported that PDAs were valuable tools that increased productivity and supported clinical decision making.

A more recent study by Moore and Jayewardene (2014) sought to describe how nurses and physicians use of smartphones in the clinical setting. A survey was conducted among N=82 nurses and N=334 physicians. It was found that 58% of nurses used smartphones while 81% of physicians used smartphones particularly for clinical decision support, calculators, formularies and textbooks. Nurse reported using experienced colleagues, protocols and guidelines more so that published research while physician respondents reported more acceptance of technology in the clinical setting. Factors that effected smartphone use were identified as costs, official endorsement, colleague recommendation, evidence of testing and validation and the belief that use would improve patient outcomes. Most participants positively viewed the use of smartphone

apps in practice citing improved access to information, improved decision making and improved efficiency.

Physicians at two community hospitals and one academic medical center were surveyed about their use of smartphones in the clinical setting. The survey was distributed to over 400 practicing physicians yielding responses from 103 physicians. Putzer and Park (2012) sought to obtain information about compatibility, observability, job relevance, and personal experience, internal and external influences on user attitudes towards smartphone use. Compatibility (β=.71), job relevance (β=.62) and internal environment (β=.62) had a more significant impact on smartphone use than personal experience (β=.23). Compatibility with other devices or technology in the hospital directly affected use. Physicians considered improved patient care, access to laboratory values, viewing diagnostic results and retrieving relevant research articles to aid in clinical decision making as important factors in using smartphones in practice.

Researchers used descriptive analyses to assess the prevalence of sleep disorders, particularly OSA and the methods in which primary care clinicians detected those disorders. Data was gathered from 44 randomly selected healthcare clinics from within practice based research networks. On any given day, 90% of the patients seen in the practices experienced sleep symptoms. Mold et al. (2011) interviewed primary care clinicians and sleep medicine specialists, reviewed 25 medical records of confirmed OSA patients and 25 medical records of patients without OSA and finally, distributed patient surveys. Patient completed Berlin questionnaires were used to assess OSA risk and showed that over 1/3 of the patients surveyed were at high risk for OSA. For patients that had a history of confirmed OSA, researchers created posters and placed in patient rooms

to remind patients to inform their clinician that they were being treated for OSA. Researchers found that patients did not discuss their sleep issues with their primary care clinicians and thus, there was no documentation of sleep symptoms in their medical records. Primary care providers were asked to identify patients within their practice that had a diagnosis of OSA however only 14 of 45 were able to identify 25 patients. This was in contrast to the data extracted from 725 patient charts with known OSA. According to researchers, 83% of those patients had sleep symptoms annotated within their charts.

A comparison of verbal history taking and questionnaires was researched by Senthilvel, Auckley, and Dasarathy (2011). Set in the primary care setting, N=101 consecutive patients being seen for new patient evaluations were approached to take part in the study. The goal of the study was to assess if primary care providers obtained sleep histories or reviewed sleep complaints during the patient encounter. Following the visit, patients were asked to complete the Cleveland Sleep Habit questionnaire (CSHQ), Berlin questionnaire, Epworth Sleepiness Scale, and STOP questionnaire. Research assistants measured the time it took for the patient to complete the questionnaires with stop watches. Post encounter and completion of questionnaires, researchers reviewed the patients' ROS and HPI within the electronic medical records for documentation of: snoring, gasping, choking during sleep, excessive daytime sleepiness, non-restorative sleep, symptoms of insomnia or cataplexy. Researchers reviewed charts for the documentation of a 4 point classification system called Mallampati score; this visual clinical assessment of the patient airway including uvula, anterior and posterior pillars as well as the soft and hard palates. Mallampati scores of 3 or 4, classified as reduced visualization of the uvula and soft palate correlate to difficulty with intubation and high risk of OSA

(Kryger, Roth, & Dement, 2011). Documentation was also reviewed for tonsillar size, and nasal passage patency, examination of neck, heart, lungs and extremities. It was found that at least one sleep related symptom was documented in 24.8% of the patient records. Insomnia was the most common sleep complaint documented by the clinician (20%) which corresponded with 29.7% positive responses on the CSHQ. A diagnosis of sleep apnea was made in 2 cases (1 new and 1 established), while 1 person was screened for snoring even though 50.5% of patients reported snoring on the CSHQ.

Sorscher (2008) used a quantitative approach to ascertain sleep inquiry. The health intake assessments were reviewed from 121 primary care clinics within the seven county Minneapolis/ St. Paul, Minnesota metropolitan area. Though 121 clinics were studied, there were only 14 unique health intake questionnaires identified. The health intake assessments were screened for questions that addressed: insomnia, hypersomnolence, sleep disordered breathing and parasomnias. No questions about sleep were identified on 8 of the forms while the remaining 6 forms asked 1-2 vague sleep related questions. No specific questions were queried however there was one section that invited the patient to check if they had sleep concerns.

Sorcher (2008) also posed two clinician centered questions: "Do family medicine physicians screen for inadequate sleep and what are the barriers to screening in the primary care setting?" Though clinicians embraced their roles as health promotion advocates, the time consuming and poorly reimbursed task of taking a thorough sleep history often deterred them for broaching the sleep question with patients. Limited community resources including the lack of qualified sleep medicine specialists and

cognitive behavioral therapists and in some regions the scarcity of sleep laboratories also posed a hindrance for some clinicians.

Zozula, Rosen, and Jahn (2005) sought to determine the effect of educational interventions on the diagnosis and management of sleep disorders in the community setting. Ten in-services were provided to medical residents and attending physicians as well as all staff over a 4 year period. The study was conducted in a health clinic with a large indigent and minority population. Researchers partnered with a local hospital based sleep laboratory and sleep medicine services were provided regardless of the patients' ability to pay. Zozula, Rosen, and Jahn (2005) measured the number of sleep referrals prior to the intervention, health care databases and patient charts for patterns of sleep disorder recognition. Pre-intervention referral rates were 0.06% while post intervention referral rates rose only slightly to 0.21%. Similarly, the prevalence of sleep related diagnoses increased from 0.11% to 0.26%. Despite the availability of sleep medicine services, researchers found that many patients did not complete the sleep study and/or follow through with treatment plans.

Hayes, Murray, Castriotta, Landrigan, and Malhotra (2012) presented qualitative research to describe multidisciplinary approaches to sleep disorders management specifically OSA and shift work disorder (SWD) and the obstacles to referral to sleep medicine specialists. A mixed- method approach was taken using semi-structured interviews, discussion groups and online surveys. General clinicians (n=165) and specialists (n=12) were used in the study. The general clinicians did not prioritize sleep complaints and lacked understanding of the impact of sleep disorders on activities of daily living. Generalist expressed a general lack of knowledge (OSA 57.7%; SWD

78.7%) and comfort with assessing sleep disorders, initiating treatment plans, managing sleep complaints and managing polypharmacy. Though the study group did not adequately address sleep complaints, they did not refer to sleep medicine as some did not view sleep medicine as a true specialty and diagnostic sleep centers were viewed with skepticism. Other generalist lacked knowledge as to which patients should be referred, when to refer and who to refer to.

Descriptive studies identified looked at the use of handheld devices in clinical practice as well as clinicians' approach to sleep health inquiry. Given the daily usage of smartphones particularly in clinical practice (Yaman et al, 2015), delivery of clinical policy within mobile app format could be helpful for clinicians (Charani et al., 2012). In the study done by Moore and Jayewardene (2014) physicians surveyed were more accepting of technology in the clinical practice while nurses preferred to use experienced colleagues, protocols and guidelines. Smartphone use among physicians in the southeast region was dependent on organizational support, intent to use and the usefulness to clinical practice (Putzer & Park, 2012). According to Stroud, Smith and Erkel (2009) PDA or handheld device use can be beneficial to clinical practice as diagnosis support and nurse practitioners use of PDAs is comparable to physician counterpart use and specially designed mobile apps seem to have a positive effect on specific educational delivery (Rajpaul and Acton, 2015).

As previously discussed, primary care providers generally did not identify patients at high risk for OSA and most patients did not discuss sleep symptoms with their clinician even with the additional time afforded with new patient examinations (Mold et. al, 2011; Senthilvel, Auckley, & Dasarathy, 2011). Generalists were not comfortable with

identification or management of sleep disorders particularly OSA and SWD (Hayes et al., 2012). The use of a validated sleep tool can be beneficial in identification of sleep disorders in primary care however the currently used health history forms and Review of Systems forms did not address sleep health adequately (Senthilvel, Auckley, & Dasarathy, 2011; Sorscher, 2008). According to sleep specialists, medical providers still refer more frequently then subspecialists and self- referrals (Mold et al. 2011). Educational intervention can help increase clinician awareness and appropriate referral, however, follow through is affected by not only clinician screening but patient compliance as well (Zozula, Rosen & Jahn, 2005).

Guidelines

The American Academy of Sleep Medicine, AASM, has developed numerous clinical guidelines and protocols for the management of various sleep disorders by board certified sleep specialist however only two clinical guidelines pertaining to primary care were found during the literature search. The American Academy of Sleep Medicine Task Force developed a guideline for long term care of patients with obstructive sleep apnea (Appendix A.1). Standards of practice include a thorough sleep history and physical as well as comprehensive evaluation of those at high risk for OSA. This population would include those who are overweight, candidates for bariatric surgery and those with a history of atrial fibrillation, type 2 diabetes, CVA, nocturnal dysrhythmias, hypertension, pulmonary and refractory, as well as populations in high-risk driving careers such as commercial truck drivers. The patient history should include questions about witnessed apnea, snoring, excessive sleepiness, gasping/choking while sleeping, morning headaches, nocturia, sleep fragmentation, decreased concentration and memory and total

sleep time. The suggested sleep assessment questionnaire is the Epworth Sleepiness Scale. If the patient history and examination suggests sleep disordered breathing then the primary care provider can refer for additional testing or refer to a sleep specialist.

In laboratory and at home polysomnography are the two acceptable diagnostic tests depending on the severity of symptoms and physical examination. Both methods will provide objective data to confirm or refute the diagnosis of OSA. In home sleep studies can be utilized only if the patient meets specific criteria and is not at moderate or high risk for OSA. Obstructive events are reported in apnea/hypopnea index (AHI) or respiratory disturbance index (RDI). Development of scoring criteria is based on the association between increased cardiovascular disease risk and increased obstructive events according to the AASM International classification of sleep disorders (2005). Patients with an AHI of ≥5 and ≤ 15 are classified as having mild sleep apnea and treatment is based on symptomology and quality of life. A patient with an AHI of ≥ 15 and ≤30 is classified as having moderate sleep apnea and is symptomatic is educated on the condition and referred for treatment options. Any patients with an AHI ≤ 30 is classified as having severe sleep apnea is referred for treatment and follow up. The guideline goes on to outline treatment options including positive airway pressure devices, oral appliances, surgical intervention and adjunctive therapy. This guideline offers a thorough evaluation and management of obstructive sleep apnea in any setting. This guideline was given an overall AGREE II score of 5. Review of this guideline determined that there is no evidence that the views and preference of the target population was sought, the method of systematic review was not fully described and external review was

not discussed. Facilitators and barriers of practice guidelines were not clearly described or potential resource implications.

The Ministry of Health, Social Services and Equality utilized a systematic review approach to develop guidelines for the management of patients with insomnia in primary care (2009) as well. An in-depth patient history is the essential first step of correct diagnosis and treatment. Detailed information should be obtained including psychiatric, sleep and substance abuse history. The guideline suggests that the primary care provider differentiate between acute and chronic insomnia and identify potential triggers. Cognitive behavioral therapy is recommended concurrently with sleep hygiene and health education. The first choices for psychological treatment to implement in the primary care setting are relaxation therapy, stimulus control and sleep restriction. If the provider chooses to use pharmacological intervention, hypnotics are indicated for short term use, less than 4 weeks, and at the least possible dosage. Short term use of benzodiazepines, 2-4 weeks, should be restricted to acute insomnia patients to prevent dependence. The guideline goes on to discuss other treatment options and considerations i.e. treatment of patients diagnosed with depression, insomnia in the elderly and herbal supplements. This guideline was given an overall AGREE II score of 6 due to its high quality and clear, concise direction (AGREE, 2009).

Case Studies

Lamm, Poeschel, and Smith (2008) presented the only case study identified. Authors presented a middle aged physically fit agricultural worker with progressively worsening fatigue, irritability and lower extremity pain. The patient had several blood

tests done which were negative for rheumatoid disease, autoimmune disease and Lyme disease. He had no family history of rheumatoid arthritis. This case continued to baffle his provider. Due to the continued complaints of ankle soreness and stiffness, the provider referred him to orthopedics where he received a MRI. The MRI showed tendon enlargement in the absence of prior injury. He was tried on oral anti-inflammatory medications, indomethacin and received cortisone injections at the site of his pain. Pain was unresolved with pharmacological intervention and the patient was ultimately referred to rheumatology and polysomnography after his spouse reported witnessed apnea. The patient was diagnosed with OSA and started on nightly continuous positive airway pressure. The patient's pain level was greatly improved within 2 weeks of CPAP initiation and methotrexate. Though the patient was not initially seeking care for sleep apnea, his unexplained pain seemed to be worsened by the untreated OSA. Lamm, Poeschel and Smith concluded that sleep disorders can be identified in any patient regardless of atypical presentation.

2.5 Synthesis

A majority of the research was related to the use of handheld devices in clinical practice. Smartphones and m-health technology is, in fact, used among health care providers in clinical practice (Gagnon et al. 2015, Garrity & El Emam, 2006, Ozdalga, Ozdalga & Ahuja, 2012, Wyatt & Krauskopf, 2012, Yaman et al. 2015). The use of smartphones and handheld technology was shown to have a positive impact on clinical and evidence based research knowledge particularly mobile applications (Salbach et al, 2011, Rajpaul & Acton, 2015, Charani et al., 2012). Medical mobile apps were shown to

increase knowledge more significantly than access of internet resources or textbooks (Goldbach et al. 2014, Moore & Jayewardene, 2014).

Overall, researchers confirmed that the use of handheld devices had a positive impact on clinical practice; however, several factors cannot be negated. Technology is ever-changing therefore capturing an accurate and concise account of technology use is difficult. By the time areas of research have been identified, funding secured, study designed and results published, the technological phenomena has been incorporated into practice or become obsolete. Additionally, technology use to support practice seems to be more readily adapted by younger clinicians which can negate more experienced practitioners that may also benefit from the use of electronic tools (Garrity & El Emam, 2006). Internal factors effecting use of mobile technology in the clinical setting were first and foremost perceived usefulness, ease of use, price, official endorsement, colleague and interaction recommendation, safety, and security (Moore & Jayewardene, 2014, Yaman, et al., 2015, Gagnon et al. 2015). External factors effecting clinical use of smartphones are organizational support and wireless infrastructure directly affect usability and data security poses a risk to personal health information and must be addressed (Putzer & Park, 2012).

Sleep disorder identification and management in primary care was directly influenced by physician attitudes towards sleep and their comfort with addressing sleep complaints. Clinicians did not routinely screen for sleep disorders even with the additional time afforded during new patient examinations confirming that a significant portion of patient sleep complaints go unaddressed (Senthilvel, Auckley, & Dasarathy, 2011). Though using sleep related questions in the review of systems forms did increase

the documentation of sleep complaints, clinicians did not address the complaints in a majority of the cases (Grover et al., 2011).

Clinicians expressed a general lack of knowledge of sleep disorder management or identification (Hayes et al., 2012). Many did not see the value in addressing sleep disorders citing lack of reimbursement, time and related knowledge (Sorcher, 2008). Zozula, Rosen and Jahn (2005) studied the effect of educational intervention on clinician's referral rate to sleep medicine services which proved to be only partially successful. Health history forms for annual and new patient visits rarely mentioned sleep complaints according to the study by Sorcher (2008). Patient compliance and willingness to seek diagnosis and treatment must be considered to increase success rates.

Multiple articles provided validation of questionnaires, methods and approaches to addressing sleep health in primary care however none of the approaches have yet to gain wide spread use or support. Behar et al. (2013) described mobile applications specifically designed for sleep health including several validated tools with electronic scoring features however these applications are available in the European markets and have not been peer reviewed. A key component to increasing sleep complaint awareness lies with active patient engagement in the process. Several patient completed tools were identified to aid clinicians in identifying sleep disorders and comparable risk. Though validated in a perioperative setting, the STOP BANG tool was highly sensitive to patients with moderate to severe OSA (Chung et al., 2008). Chai-Coetzer et al. (2011) OSA50 showed a significantly predictive assessment of moderate to severe OSA. The patient completed validated tools, Berlin Questionnaire, Epworth Sleepiness Scale and Cleveland Sleep Habit Questionnaire, have been used to identify negative sleep habits and potential

risk for sleep disorders among primary care patients (Epstein et al., 2008; Schutte-Rodin et al., 2008) Again, the availability of the information provided by the patients did not increase documentation or follow up by clinicians.

Summary

Primary care practitioners are faced with the daunting task of managing multiple medical issues in a short amount of time. Research confirms knowledge gaps and dismissive attitudes towards sleep health assessment among primary care providers. Clinicians are becoming more aware of the effects of OSA on the overall health but simply asking about sleep health has not become common place in patient visits. The literature demonstrated the ability of practitioners to address sleep complaints was negatively impacted by time constraints, reimbursement and limited knowledge of sleep health. Although a formal assessment of barriers to the use of mobile application technology for assessing and managing sleep disorders was not conducted among the providers for this project, informal discussions with providers unveiled they did not administer sleep documentation tools or questionnaires, complained of limited time for patient education during office visits, and they admitted to limited knowledge of sleep health beyond asking one or two questions. They did use one mobile application for accessing clinical guidelines for unusual patient presentations but did not use it for assessing or managing common or routine complaints, including sleep.

Web based guidelines for the diagnosis and management of insomnia, restless leg syndrome and OSA are available from the American Academy of Sleep Medicine and the National Guidelines Clearinghouse, however, the utilization of these guidelines in this

population has not been studied. Researchers have sought to develop new approaches to increasing awareness with little success.

M-health technology or smartphone use has been studied in a variety of settings to evaluate its effects on clinical knowledge and practitioner adherence to guidelines. No studies were found using educational technology to address sleep disorders identification and management in primary care. Most research has been positive however quality and rapidly changing technology presents limitations. Peer review, usability, data security and wireless infrastructure can enhance or deter clinicians' use of technology.

MySleep101© is available for download on smartphones and could increase comfort levels and knowledge base about sleep health prompting regular evaluation of sleep complaints throughout their practice.

Table 2.1

Sleep Terms Literature Search Results

Database	Keywords	Results
CINAHL Plus with Full Text	1. Primary care + sleep diagnosis 2. Primary care + sleep assessment 3. Family medicine + sleep assessment 4. Family medicine + sleep diagnosis 5. Primary care + sleep disorders 6. Primary care providers + sleep diagnosis 7. Sleep disorder + assessment + primary care	7 0 0 0 0 0 0
PUBMED.gov	1. Primary care + sleep disorder + recognition	2
MEDLINE EBSCO with Full Text	1. Sleep disorders + primary care	0
Cochrane Library	1. Primary care + sleep disorder 2. Primary care + sleep assessment	0 0
Joanna Briggs Institute	1. Primary care + sleep assessment 2. Family medicine + sleep diagnosis	0 0
Bibliography references		3

Table 2.2

Technology Terms Literature Search

Database	Keywords	Results
CINAHL Plus with Full Text	1. Smartphone adoption 2. Smartphone + education 3. Mobile application + professional education 4. Mobile applications + continuing education	6 0 0 1
PUBMED.gov	1. Smartphone + clinical decision support/making 2. Mobile technology + clinical decision making 3. Personal digital assistant + clinical decision	2 3 1
MEDLINE EBSCO with Full Text	1. Smartphones + clinical decision support	0
Cochrane Library	1. Smartphone adoption 2. Smartphone + clinical decision support/making	0 0
Joanna Briggs Institute	1. Clinical decision support system 2. Smartphone	0 0
Bibliography references from systematic reviews		3

Table 2.3

Scottish Intercollegiate Guidelines Network (SIGN) grading

Score	Criteria
1++	High quality meta-analyses, systematic reviews of research clinical trials, or research clinical trials with a low risk of bias
1+	Well-conducted meta-analyses, systematic reviews, or research clinical trials with a low risk of bias
1-	Meta-analyses, systematic reviews, or research clinical trials with a high risk of bias
2++	High quality systemic reviews of case control or cohort of studies. High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2+	Well-conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2-	Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3	Non-analytic studies, e.g. case reports, case series
4	Expert opinion

CHAPTER 3

Methods

Sleep disorders affect tens of millions of Americans (CDC, 2011). Described as a public health burden, insufficient sleep caused by sleep disorders or voluntary sleep restriction has been shown to lead to immediate as well as long term safety and health consequences. The Institute of Medicine has called for strategic approaches to address this public health issue (a) improve public education about sleep needs and the consequences of insufficient sleep (b) increase healthcare provider training concerning screening and counseling (c) identify more evidence of insufficient sleep as a public health burden (Perry, Patil & Presley-Cantrell, 2013).

A review of the literature as well as governmental data sources confirm that sleep health needs to be addressed in the primary care setting (Elliott, 2001; Senthilvel, Auckley & Dasarathy, 2011). Review of systems and/or health history forms offer an avenue for patients to communicate their sleep concerns but rarely are these concerns addressed or documented by healthcare providers (Sorscher, 2008; Grover et al., 2011; Senthilvel, Auckley & Dasarathy, 2011). Descriptive studies corroborate the increased number of sleep disorders among the primary care population, however, clinician knowledge and attitudes about sleep health vary depending on experience, training and time constraints (Hayes et al., 2012).

Finally, sleep health is largely ignored in the primary care setting; however, widespread use of handheld technology such as smart phones may provide a solution to this issue. Although a formal assessment of barriers to the use of mobile application technology for assessing and managing sleep disorders was not conducted among the providers for this project, informal discussions with providers unveiled they did not administer sleep documentation tools or questionnaires, complained of limited time for patient education during office visits, and they admitted to limited knowledge of sleep health beyond asking one or two questions. They did use one mobile application for accessing clinical guidelines for unusual patient presentations.

Application of Lewin's Change Theory in combination with key components of the literature synthesis will be used to frame the methods for this research utilization project. The purpose of this chapter is to present the methods for conducting this quality improvement project.

3.1 Setting

The health center is located in a South Carolina that provides an onsite primary care family practice for employees, retirees and their dependents. It is a full service primary care practice with a board certified family medicine physician and three board certified family nurse practitioners. The health center also provides an Employee Assistance Program counselor, physical therapy services, and Condition Management services. The facility has onsite laboratory services and 6 patient examination rooms, open Monday – Friday 7:00 AM to 7:00 PM and Saturdays 7:00 AM-1:00 PM. Company practice models dictate that visits are scheduled for 30 minutes for follow up, episodic or acute visits, and 1 hour for any type of physical examination including annual,

gynecological, work or sports physicals. The health center was opened in August 2014 and is seeking accreditation from AAAHC as a patient centered medical home within the next 18 months. This clinic provides services for employees, a combined 2100 people. The dependent population is estimated to be greater than 5000 lives.

3.2 Sample

Two providers were selected for this project. They included on physician and one Nurse Practitioner. Only three providers were employed at the facility, 2 full time and one part time. The full time providers were one 67 year old Caucasian male board certified family physician and one 38 year old female board ANCC board certified family nurse practitioner. At the time of the project, only the full time clinicians saw enough patients to provide sufficient data for the study. The part time practitioner provided significantly more episodic and acute care encounters.

A total of 120 adult charts selected were reviewed to ascertain the clinicians' documentation for sleep quality, hours of sleep, sleep disorders, sleep medications, referrals, and sleep hygiene education in adult patients. Thirty different patient charts for each provider were reviewed for data for a combined total of 60 charts during the pre-intervention period. The investigator reviewed any subsequent visits for the same 60 patients during the post intervention phase. Adult patients seen for annual physicals, adult gynecological annual examinations, employment physicals, non-cute visits were reviewed for the annotation of sleep quality, hours of sleep, sleep disorders, sleep medications, referrals, and sleep hygiene education during a 6 month period for the project phase. The inclusion criteria for the chart data extraction were: adult patients ages 18-75, annual physicals, adult gynecological annual examinations, employment

physicals, non-cute visits who presented for services between October 2015 and March 2016.

3.3 Design

This quality improvement project used an educational model intervention related to sleep disorders. Measures for the chart review pre and post-intervention included documentation of sleep quality, hours of sleep, sleep diagnoses, sleep medications, referrals if appropriate, and sleep hygiene in adult patients who presented for services. Sleep health knowledge was also assessed pre- and post-intervention using a knowledge questionnaire.

Providers were provided an educational medical mobile application developed by the Johns Hopkins University School of Medicine entitled MySleep101©. This mobile application utilized an animated educational approach divided into eight modules and three clinical vignettes designed to educate non sleep specialists on common sleep disorders and management using a mobile application. Each healthcare provider was guided through downloading the mobile application onto their personal device and given an individual training lasting 15-20 minutes on its functionality and use in the clinical setting. A review of the patient charts for documentation of sleep quality, hours of sleep, sleep disorder diagnoses, sleep medications, referrals if appropriate, and sleep hygiene education in adult patients pre and post intervention was used to evaluate the effectiveness of the educational approach on clinicians' practice for assessing sleep disorders in adult patients. This descriptive study also evaluated the practitioners' individual knowledge of sleep health utilizing a 30 item tool, the ASKME survey (Zozula et al., 2001) pre and post intervention.

3.4 Unit of Analysis

The unit of analyses included a pre and post intervention chart review of documentation of sleep quality, hours of sleep, sleep disorder diagnoses, sleep medications, referrals if appropriate, and sleep hygiene education in adult patients. A data collection tool was used to gather specific data from 120 adult patient visits (Appendix B). The second unit of analysis was the provider's demographics, general knowledge of sleep, and mobile application use as measured by the ASKME Survey pre and post intervention found in Appendix D.

3.5 Outcomes to be measured

A chart review form was used to collect patient chart data on the primary care providers' assessment and management of patients seen pre and post intervention (Appendix B). This data was analyzed by using two sample t-test statistical analyses. The instrument consisted of five columns: Sleep Quality, Hours of Sleep, Sleep Medication, Referrals if Appropriate, and Sleep Hygiene with options YES/NO under each category. If the clinician addressed the particular subject in the History of Present Illness, Review of Systems, Assessment or Plan, YES is indicated. If the practitioner did not document the particular subject of interest in any area of the medical record, NO is indicated. A total of 120 patient visits were retrieved for analyses. No patient identifiers were used in data collection except to match charts during the pre and post intervention period. For example, Chart A (pre) was matched with Chart A (post) for data collection only. No personal or demographic information was collected.

Descriptive data was collected for providers' demographics (Appendix C). The instrument consisted of six questions that pertained to the clinicians' personal smartphone use in the clinical setting. This survey asked about the model and/or platform of smartphone used by the practitioner on a daily basis, iOS© or iPhone © or Android © platform. This questionnaire also asked practitioners about the mobile medical applications most used by them for personal or professional use. The additional information collected on each provider included gender, number of years in practice, and number of years in current position. No other personal identifiers were collected.

The physician and nurse practitioner's knowledge of sleep health was assessed using the instrument in Appendix D. The survey consisted of 30 true, false or I don't know items administered pre and post intervention. The 30 item ASKME Survey (Zozula et al., 2001) was constructed to assess baseline knowledge of students in a variety of disciplines, clinical psychology, medical students, nursing, other health disciplines, established physicians and sleep specialists. The ASKME Survey was shown to have a high degree of internal consistency, KR-20=0.89 (Zozula et al., 2001). Among the 213 subjects in this study, the most correct responses were seen in subjects in the accredited sleep specialist group (85.3% ± 10.8%) while the nurses represented the lowest percent correct (53.1% ± 13.7%). The 30 items cover 6 categories: basic sleep principles, circadian sleep/wake control, normal sleep architecture, common sleep disorders, medical and psychiatric illness and sleep, effects of drugs and alcohol on sleep. The items are scored by True/False or I don't know format for ease. The items were balanced providing True and False responses in each domain to minimize the effects of random guessing.

3.6 Framework

Changing practice behaviors within the primary care community requires a clear and comprehensive theoretical framework to improve sustainability. Kurt Lewin's 1940's change theory offers a relevant approach to changing practice behaviors. This theory has three major components which include unfreezing, transition and refreezing (Dulaney & Stanley, 2005). The unfreezing phase serves to change the current mindset and debunk resistance to the intended change. This stage brings about realization for a necessary change. Essentially, primary care providers were presented with a thought provoking problem that required a solution. For this project, primary care providers were presented with the question of incidence and prevalence of insufficient sleep in their population as well as what methods were currently used to identify sleep health within their office. Administration of the ASKME questionnaire (Zozula et al., 2001) offered the primary care providers a way to gauge their current sleep knowledge. This phase was intended to increase awareness of sufficient sleep as an important health behavior and hopefully invoke a thought provoking dialogue about their personal clinical practices in this area. According to Dulaney and Stanley (2005), unfreezing serves to decrease resistance to the intended change and prepare for the transition phase. Providers did not resist the change to using the mobile application but did require some teaching on the use of the mobile application and sleep assessment/management.

The second phase of Lewin's change theory is the process of transition or change. Transition involves facilitating and encouraging new behaviors, practices and attitudes towards the defined problem (Dulaney & Stanley, 2005). The tools and solutions identified in the unfreezing stage are incorporated into practice but not without some

confusion. In this stage, the mobile medical application, MySleep101©, was downloaded onto their Apple © devices during the monthly provider meeting. It was important in this stage to provide support, coaching and anticipate challenges as changing from old ways to new ways can cause uncertainty (Dulaney & Stanley, 2005). A 15 minute in-service was held to review the first learning module, Basic Sleep Concepts, together via projection screening as well as app functionality and troubleshooting was done during this session. Changing practice behaviors required constant re-enforcement.

The third phase is refreezing which solidifies the new norm for the organization. The main component would be reinforcement of the change and supporting the new desired change (Dulaney & Stanley, 2005). The assumption is that the healthcare organization will return to old practice behaviors without adequate re-education and re-enforcement. The clinicians were asked to review each of the 8 modules over a 10 day period as well as the 3 clinical vignettes. Following the review period, the providers are asked to keep the mobile app available with them for review of information during the duration of the study. Healthcare organizations are required to have a quality improvement program in place; this is an ideal juncture to identify the frequency and quality of sleep health inquiry. To ensure that the practice change was solidified, sleep health inquiry was suggested as a quality improvement study for the practice. By incorporating this change, sleep health will likely become an essential part of outcome measurement.

3.7 Description of intervention (Mobile Application)

The mobile medical application, MySleep101©, was developed by the Johns Hopkins Dream Team© and released in May 2015. The content developers were two

sleep neurologists, Rachel Salas, MD and Charlene E. Gamaldo, MD, and sleep behavioral psychologist, Luis F. Buenaver, PhD. This application was designed to offer teaching on the use of a mobile application and scientific information on seven of the most common sleep disorders:These disorders are insomnia, sleep apnea, circadian rhythm disorders, restless leg syndrome, hypersomnias, parasomnias and post-traumatic stress disorders This app provides non sleep specialists with detailed risk factors, symptoms and strategies for management (Johns Hopkins, 2015). Disclaimer information reveals that this app is not intended for use as a diagnostic tool but does offer valuable information. Currently, this app is only available through the App Store© for iOS costing $3.99 for the full version of the app.

MySleep101© consists of 8 educational nodules and 3 clinical vignettes. All of the modules utilize avatar likenesses of Rachel Salas or Charlene Gamaldo, who also serve as narrators for each module. Upon opening the mobile app, the user is given the option to select any of the following learning modules: Basic Sleep Concepts, Restless Leg Syndrome, Hypersomnia, Insomnia, Sleep Apnea, Circadian Rhythm Disorder, Parasomnia, Post-traumatic Stress Disorder. The user can also select clinical vignettes entitled: Can't Stay Asleep, Asleep at the Wheel or Excessive Daytime Sleepiness. Selecting any title will take the user to the desired module.

Basic Sleep Concepts provides a brief lecture series on sleep biology and physiology. This 14:49 module is narrated by Rachel Salas and uses animated notes to illustrate key points. Rachel starts by reviewing sleep architecture including NREM and REM along with sleep staging and scoring utilizing electroencephalography (EEG). Citing the Sleep Academy and the National Sleep Foundation, the narrator outlines basic

human sleep needs, 7.5-8.5 hours per night as well as normal sleep latency which is approximately 10 minutes. Normal sleep, NREM/REM cycles, circadian rhythms, melatonin and homeostatic processes are reviewed. The aging process and how it relates to sleep highlighting increasing sensitivity to hormones and its effect of length and quality of sleep is reviewed. The economic and health burden of all cause sleep deprivation discussion highlights the need for sleep education at the primary care juncture according to the mobile app.

Rachel continues to present one of the most common sleep complaints, insomnia. She differentiates between acute and chronic insomnia while defining diagnostic criteria for each. Pharmacologic treatment and an in depth discussion on cognitive behavior therapy, sleep consolidation and sleep restriction allows the viewer to become familiar with treatment options in this 14:47 minute video.

The module in MySleep101© discusses hypersomnia and narcolepsy in an 8:33 minute module. A diagnostic criterion for narcolepsy includes sleep paralysis, cataplexy, hypnagogic and hypnopompic hallucinations as well as the irresistible urge to sleep are reviewed. Diagnostic testing for hypersomnia and narcolepsy involve polysomnogram testing followed immediately by a multiple sleep latency testing. Rachel suggests evaluation by a sleep psychologist to assist with sleep behavior modification and pharmacological management for narcolepsy and idiopathic hypersomnia.

Unintentional behaviors that happen at any stage of sleep are classified as parasomnias. Dr. Salas gives a 10:08 minute overview of primary, secondary and miscellaneous parasomnias, diagnostic criteria and treatment in this module. NREM parasomnias or disorders of arousal are reviewed and they include confusional arousals,

sleepwalking and night terrors. Parasomnias that occur in the REM stage of sleep are nightmare disorders, recurrent isolated sleep paralysis and REM behavioral sleep disorders. Dr. Salas provides users with sleep behavioral that warrant sleep medicine referrals. Behavioral modification and ruling out other diagnoses is essential if parasomnias are suspected.

The restless leg syndrome or Willis-Ekbon Disease module provides diagnostic criteria, risk factors and treatment strategies. Dr. Charlene Gamaldo uses the 17:53 segment to provide learners with the information needed to identify and manage this clinical manifestation. There are four essential features of RLS including irresistible urge to move that start in the patient's lower extremities, more prominent at rest, improvement in the symptoms with physical and mental movement and worse in the evening or at night. Dr. Gamaldo reiterates that this is a diagnosis that is made clinically not by polysomnogram and reviews the fifth component that the practitioner should consider which is ruling out any other RLS mimics like neuropathy. The Johns Hopkins Diagnostic Questionnaire and the Cambridge Diagnostic Tool on RLS are cited by Dr. Gamaldo to assist clinicians in eliciting subjective information from patients.

Dr. Gamaldo describes the sleep apnea as a 15 minute elevator chat. Sleep apnea is often under-diagnosed, misdiagnosed and undertreated in America (CDC, 2011 (b). Risk factors like weight, age, gender, recreational activities and facial features are linked to increased risk for sleep apnea. Dr. Gamaldo reviews risk factors, common complaints and co-morbid conditions. An overview of PSG changes found in a patient with sleep apnea including hypopneas and apneas is given. Presentation in patient complaints can be attributed to gender. For example, according to Dr. Gamaldo, women tend to present with

insomnia versus the typical male presentation of partner complaints of snoring and witnessed apnea. Sleep apnea therapies like positive airway pressure, positional therapies, dental appliance and behavioral modification are reviewed.

An 8:38 minute module is used to present information on circadian rhythm disorder. Sleep cycle, circadian rhythm and homeostatic drive inter-relationship as well as consequences are reviewed. Dr. Gamaldo describes shift-work disorder, found in patients that work rotating night shifts which directly conflicts with the body's natural circadian rhythm. Six to fifteen percent of adolescents and young adults who present with delay sleep phase disorders are typically called night owls as the circadian rhythm dips later than 11pm. Early birds or those that have advanced sleep phase disorder have little difficulty getting up at 4am or 5am but have difficulty staying awake in the evenings. Dr. Gamaldo goes on to discuss sundowning as it relates the 66% of patients suffering with Alzheimer's disease.

The module that introduces Post Traumatic Stress Disorders, PTSD, and its effects on sleep is discussed in a 12:05 minute segment. According to this module, women are twice more likely to develop PTSD than men and 61% of men and 51% of women experience at least one traumatic event in their lifetime. Risk facts like experiencing or witnessing traumatic events, rape, motor vehicle accidents and combat situations are examples of PTSD. Other risk factors include history of child abuse or substance abuse, recent loss of a loved one, insufficient social support, being young or having a lower educational level. There is also possible link between military service members with difficulty sleeping prior to deployment are at increased risk for developing PTSD, depression and anxiety upon return. The module discusses the diagnostic criteria

for PTSD like stressors, emotional distress, and avoidance, negative changes in thought and feelings and nightmares. Exposure therapy, stress inoculation training and cognitive processing therapy are reviewed as treatment options for PTSD. All of the modules teach the use of a mobile application for providers on their personal mobile devices.

3.8 Procedure

Protected health information or patient identifiers for data analyses were not collected for the project. University of South Carolina Institutional Review Board (IRB) determined that this was not human subject research and an exempt status for approval was obtained prior to project implementation. The investigator provided a 15 minute presentation during April 2016 to discuss the project and project requirements with providers.

After the introductions and discussion of the project, the physician and nurse practitioner were asked to complete the paper 30 question pre-intervention knowledge survey about sleep health and the demographic questionnaire concerning the clinicians' personal smartphone use in practice. Following the survey, a review of 30 patient encounters were selected for each provider from the electronic medical records system. . Records were selected from every third patient seen during this time period. The information extracted from these charts was annotation of sleep quality, hours of sleep, sleep medication, sleep hygiene and if sleep medicine referrals were made. Patient charts were accessed electronically from the PrimeSuite© electronic medical records and no patient identifiers were collected from the records. The spreadsheet used to collect the presence or absence of the annotated information of interest was stored in a secure encrypted file for transfer for analyses at the College of Nursing data storehouse.

After the completion of these tasks, the investigator utilized the conference room smart television to project the mobile application module, Basic Sleep Concepts, from an iPad to give instruction on the use of the application. The investigator then provided a demonstration of the application and answered any questions from the providers. After completion of 14:49 minute video, the clinicians were provided with a $10 iTunes gift card and assisted in the download of MySleep101© from the Apple App Store©. After successful download, they were assisted with launching the app on their smartphones. The nurse practitioner colleague did not have an Apple iOS© device, therefore a personal iPad Mini with the mobile application pre-loaded was provided to the clinician for use and available to the practitioner for the duration of the study. At the conclusion of the training, they were asked to have their smartphone and/or tablet device available during clinic hours to reference MySleep101© material. The investigator was available for questions onsite for the duration of the project.

After collectively viewing the Basic Sleep Concepts learning module, and downloading the mobile application to the provider's mobile devices, the providers were asked to view all modules by April 26, 2016 which was 5 days after the monthly provider meeting. Each provider verbally stated that they completed all modules. At the conclusion of this 5 day period, another review of patient encounters, 30 per full time provider, was conducted. Additionally, the providers were asked to complete the ASKME Survey as a post-intervention activity and return to the investigator. Their individual scores on the sleep knowledge survey were compared to their individual scores from the same survey pre-intervention.

3.9 Data Analysis

The chart review form was designed to collect data on the primary care providers' assessment and management of patients seen pre and post intervention on 60 charts pre-intervention and 60 charts post intervention. The number of patient charts with documentation of sleep quality, hours of sleep and sleep hygiene among adult patients was calculated as percentage as well as the change, if any, in number of referrals to sleep medicine. The form in Appendix C was presented for clinician demographical information and smart phone usage in clinical practice.

The ASKME survey was presented to assess the clinicians' knowledge of sleep assessment and management. The survey consists of 30 items answered dichotomously as true or false. The practitioners' pre-intervention knowledge was compared to their post-intervention knowledge represented by the scores received with both administrations. The survey was collected by paper and entered into a data excel spreadsheet for analysis.

Summary

Two full-time primary care providers treating adult patients at the employee health center were asked to utilize a medical mobile application, MySleep101©, to learn about sleep related health problems and management. The use of the three components of Kurt Lewin's Change Theory were used as the framework for this project. The first phase, unfreezing was initiated by presenting the clinicians with a sleep knowledge and technology usage survey. The transition phase was facilitated by asking the two providers to download the mobile application on their smart phones and review the 8 educational modules and 3 clinical vignettes. The change in the number of adult annual visits with documentation of sleep quality, hours of sleep, sleep hygiene and sleep medication as well as appropriate sleep specialist referrals were used as measurement outcomes. The

practitioners' general knowledge of sleep was used as measurement outcomes as well. The matched t-test and descriptive statistics were used to analyze the data. The refreezing phase, or reinforcement stage, involved incorporating sleep inquiry into the clinic peer review or quality improvement process. Despite the barriers cited to assessing sleep concerns in the literature, the assumption was that by utilizing the mobile application even for a specified length of time, sleep health awareness, knowledge and documentation would be increased by primary care providers.

CHAPTER 4

Results

Sleep patterns and disorders are typically inadequately assessed in primary care, even though evidence shows that the cost of poor sleep patterns and sleep disorders impacts well-being, work productivity, driving habits, and academic performance. The goal of this project was to determine if access to an educational mobile app would positively affect sleep medicine knowledge and documentation regarding the assessment and management of sleep health Inferential statistics including McNemar's test and Kappa agreement were used to describe shifts in behavior and knowledge over the 3 month period for this quality improvement study. Though clinical knowledge of sleep health improved, McNemar's test indicated that there was insufficient evidence overall to establish practice change ($p > 0.05$. Descriptive Statistics are shown to demonstrate sample demographics and findings.

4.1 Description of sample

The study consisted of patients seen by two primary care health providers at a South Carolina employee health clinic. Both providers used a mobile device with downloaded applications for clinical guidelines for assessing and managing health problems, including sleep disorders.

4.2 ASKME Survey Results

The knowledge of the healthcare providers was assessed utilizing the ASKME Survey prior to the implementation of the intervention. The physician participant answered 20 questions correctly out of 30 (67 %) during the pre-intervention period, this included 2 responses of "I Don't Know". Similarly, the nurse practitioner participant answered 20 questions correctly out of 30 questions (67 %). During the post intervention period, the MD answered 25 questions (83 %) correctly without any "I don't know" indications. The nurse practitioner correctly answered 24 questions (80 %) in the post intervention period which was 4 more than pre-intervention. Both MD and nurse practitioner increased the number of corrected answered after intervention. The physician had a slightly higher percentage (83 %) of correctly answered questions as compared to nurse practitioner (80 %).

4.3 Analysis of PICO

Among primary healthcare providers, does the use of an educational sleep medicine mobile application (app) improve the assessment and management of sleep disorders in primary care settings by primary care providers? The project PICOT sought to determine if access to an educational mobile app would positively affect sleep medicine knowledge and documentation regarding the assessment and management of sleep health in terms of sleep quality, hours of sleep, sleep disorders, sleep medication, sleep hygiene and sleep referrals. Table 4.1 and 4.2 shows sleep quality was documented for 1 patient (3%) and 3 patients (10%) by the physician and nurse practitioner while hours of sleep and sleep referrals were not addressed at all by either practitioner. In the

months preceding this study, use of sleep medication or sleep aids was not documented by the nurse practitioner, however the physician documented use of sleep medication in 2 patient charts (6.67%). Sleep hygiene was another area that was neglected. The physician documented sleep hygiene in 1 patient chart (3.33%) while the nurse practitioner participant had no documented sleep hygiene.

The post intervention period data in Table 4.3 was analyzed to determine if there was any change in clinical behavior. The physician participant did not address sleep quality, hours of sleep or initiate any sleep medicine referrals during this period. Sleep medication was documented in 2 patient encounters (6.67%) while sleep hygiene documentation was the area with the most increase from 3.33% to 23.33% of the 30 patient encounters.

Table 4.4 illustrates the nurse practitioner documentation of sleep health during the post intervention period. The nurse practitioner addressed hours of sleep and sleep medication in 4 patient charts (13.33%). Sleep quality was addressed in 10 patients (33.33%) out of 30 patients. One sleep referral was initiated during this period. Sleep hygiene was documented in 5 patients (16.67%).

The McNemar's test confirmed statistical significance for the physician post-intervention sleep hygiene documentation ($p = .0339$) and nurse practitioner post-intervention sleep quality ($p = .0348$) clinical behaviors as p values were less than 0.05.

Further statistical analysis was completed to determine agreement between the physician and nurse practitioner clinical practices. There was moderate agreement between the physician and nurse practitioner in the sleep quality pre-intervention period

($p<.05$) (Table 4.5). The post-intervention practices showed a fair agreement concerning documentation of sleep medications and only a poor agreement in terms of sleep hygiene. There was no agreement in any other areas of clinical documentation including management (medication, hygiene, referrals).

Physician and Nurse Practitioner Response

Following the project intervention, a meeting was held with providers to ascertain their informal comments on the use of the mobile application. The full time primary care providers involved in this study verbalized positive responses to several components of the project. The nurse practitioner commented that MySleep101© was simple to use and the modules were informative. The NP denied difficulty accessing or navigating through the educational modules on the iPad Mini provided for her. Similarly, the physician also reported that the sleep medicine mobile app was easy to use, navigate and access. Both relayed an increase knowledge and awareness of sleep health after watching the learning modules even though data did not confirm the translation to practice.

The physician and nurse practitioner cited barriers to documentation of sleep health. The physician reported that often the physician overlooked or forgot to ask about sleep health even though the physician did understand the significance. The physician was unable to give a more specific cause for lack of documentation. The physician denied time constraints affecting the ability to discuss sleep since chronic disease follow up visits were allotted 30 minutes. The nurse practitioner also reported being more pre-occupied with the current chief complaint and addressing the established chronic illness that the patient was being seen for.

Summary

Assessment of sleep health is an important component of chronic disease management. In the months preceding the study, the physician and nurse practitioner participants did not regularly document sleep health in primary care patients, however increased test scores were seen on the ASKME Survey post intervention. Little change was seen in sleep health documentation. However, statistical significance was found in the post intervention sleep quality documentation for the nurse practitioner and the sleep hygiene documentation for the physician with p-values of <0.05

Table 4.1

Frequency and Percentage of Documented Sleep Health in Pre-Intervention-NP

N=30	Sleep Quality		Hours of Sleep		Sleep Medicine		Sleep Hygiene		Sleep Referrals	
	N	%	N	%	N	%	N	%	N	%
NO	27	90	30	100	30	100	30	100	29	97
YES	3	10	0		0		0		N/A	

* Insufficient data for statistical analysis

Table 4.2

Frequency and Percentage of Documented Sleep Health in Pre-Intervention- MD

N=30	Sleep Quality		Hours of Sleep		Sleep Medicine		Sleep Hygiene		Sleep Referrals	
	N	%	N	%	N	%	N	%	N	%
NO	29	97	30		28	93	29	97	29	97
YES	1	3	0		2	7	1	3	1	3

Table 4.3

Frequency and Percentage of Documented Sleep Health in Post Intervention-MD

Physician	Sleep Quality		Hours of Sleep		Sleep Medicine		Sleep Hygiene		Sleep Referrals	
	N	%	N	%	N	%	N	%	N	%
NO	30	100	30	100	28	93	23	77	29	97
YES	0		0		2	6.67	7	23	1	N/A

Table 4.4

Frequency and Percentage of Documented Sleep Health in Post Intervention-NP

Nurse Practitioner	Sleep Quality[a]		Hours of Sleep	Sleep Medicine		Sleep Hygiene[b]		Sleep Referrals	
	N	%	N %	N	%	N	%	N	%
NO	20	67.7	26 86.7	26	86.7	25	83.3	28	93.3
YES	10	33.3	4 13.3	4	13.3	5	16.7	1	3.3

*one sleep referral listed as N/A a. p value McNemar's Test= .0348 b. p value McNemar's Test= .0339

Table 4.5

Kappa Agreement for MD and NP

	Sleep Quality	Hours of Sleep	Sleep Medicine	Sleep Hygiene	Sleep Referrals
Pre-intervention	0.47	*	*	*	*
Post-intervention	*	*	0.27	0.17	*

*Insufficient data for statistical analysis

CHAPTER 5

Discussion

The prevalence of sleep disorders is increasing exponentially. These under-diagnosed and under-recognized conditions affect almost every aspect of health. Even though the presence or absence of sleep disorders can be addressed as part of routine primary care visit relatively easily, sleep health is often not documented. The intent of this process improvement project was to address sleep health in the primary care setting using an educational mobile application for assessing and managing sleep disorders by primary care providers.

The increased awareness of sleep disorders and sleep health with the use of MySleep101©among the providers has prompted the onsite employee family health center to institute a sleep health quality improvement study. The QI committee has discussed surveying sleep difficulty in the worksite population and depending on the results of that study, offering meditation and biofeedback seminars for plant workers as rotating shifts are mandatory for a large portion of the employees. Additionally, the physician participant is exploring obtaining American Board of Sleep Medicine Behavioral Sleep Medicine certification.

It is unclear as to why there was little change seen in documenting sleep health. Sorcher (2008) cited that sleep assessment in the primary care setting was not only effected by lack of knowledge but time and reimbursement. These may have been factors in the consistent documentation of sleep in patient encounters. Other limitations were the small provider sample used and the length of the study. There is no way of assessing if the changes in practice behavior will be sustained however the implementation of sleep health within the QI process may sustain clinical practice. Recommendations would be to develop guidelines for the use of the mobile application, lengthen the timeframe of the study and increase the number of provider participants.

5.1 Future evidence based projects

Smartphones have become a fixture in daily life and clinical practice therefore the use of a mobile app to affect knowledge and clinical behaviors is a realistic option. The Johns Hopkins developed mobile app, MySleep101©, was created to assist non sleep medicine health care providers in increasing knowledge about common sleep disorders including assessment, diagnostic features and treatment options. Though the format of MySleep101© was informative and easy to follow according to the study participants, other mobile application formats may be more effective in encouraging practice change but this was not conducted and further study is warranted to compare mobile applications.

Clinical decision support software frameworks could offer an individualized approach to addressing sleep health with this population. At the time of this project, there were no CDSS mobile app platforms for sleep health however use of this platform had

been researched for other clinical areas. Stengel et. al (2004) compared the use of handheld CDSS and paper chart documentation and found that documentation using the structured decision tree increased the median number of diagnoses and the quality of documentation increased in respect to correct assessment of patient progress. In another large study, clinical decision support systems and appropriate antimicrobial prescribing in the outpatient setting was studied by Samore et. al (2005). The CDSS showed a decrease in inappropriate prescribing rates versus the community intervention alone. Specially designed clinical decision support mobile applications specifically developed for sleep health could show the same impact on practice behaviors

5.2 Health policy

Additionally, the importance of sleep health is gaining visibility as a public health concern and gradually appearing in health policy. Most recently, the Agency for Healthcare Research and Quality (2013) has recent added sleep health questions to its recommendations for primary care adult health assessment. Healthy People 2020 provided a revision to one of its four sleep health objectives:

"Improve the proportion of adults that get sufficient sleep."

Also, the National Centers on Sleep Disorder Research (2011) goal spoke to healthcare providers:

"*Goal 3 - Improve prevention, diagnosis, and treatment of sleep and circadian disorders, chronic sleep deficiency, and circadian disruption, and evaluate the resulting impact on human health."*

Positively impacting these objectives will take constant awareness and assessment at the primary care level.

5.3 Leadership

As awareness grows, health care leaders, taking cues from national health organizations and insurance clearinghouses, dictate which chronic health diseases warrant resources and focus by clinical teams. In the case of this study, the clinical leadership as a whole decided to incorporate sleep health into the continuous quality improvement process. This strategic step may ensure that sleep is incorporated on a local level. However, more administrative involvement is needed to allow the use of technology to facilitate provider knowledge of sleep and the use of mobile devices.

Putzer and Park (2012) provided a descriptive study that identified one of the factors that influenced the use of smartphones in the clinical site was the compatibility with existing technology and organizational support. Healthcare leaders have the ability to adapt the internal infrastructure to support smartphone usage with secure wireless networks and some form of mobile application interface with existing electronic medical records. Providers would be more likely to utilize mobile tools that could be directly input into patient records as a time saving method and reduction of duplicate assessment and charting.

5.4 Advanced Practice

Advanced practice nursing programs could be at the forefront of using mobile applications for assessing and managing sleep disorders in practice. Studies by Papp, Penrod and Strohl (2002) and Sorscher (2008) both suggest that incorporating didactic

instruction on sleep increased the likelihood of practitioners inquiring about sleep. As nursing curriculums evolve, intertwining sleep health into chronic disease management can facilitate the connection from the educational standpoint. Advanced practice nurses that are currently practicing could benefit from an increase in continuing education opportunities that incorporate sleep health. Delivery of this continuing education could be in the form of conferences, webinars, online programs and even smartphone delivery. Regardless of the access point to the knowledge, advanced practice nurses can be the primary catalyst to changing practice in this area.

Summary

This project represents a start in raising awareness and addressing barriers to sleep health assessment in primary care. MySleep101© offers easy to follow learning modules to refresh the primary care providers knowledge base of sleep. Primary care providers represent the front line for chronic disease management. The CDC (2016) estimated that over 928.6 million visits were made to a health care provider in 2014-2015. Of these visits, 54.6% of these visits were to primary care providers. Each of these encounters represented an opportunity for primary care providers to address sleep health. Whether the factors are time, knowledge, familiarity, importance, reimbursement each has to be explored to increase the frequency of documentation of sleep.

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APPENDIX A

Evidence Table

Brief Citation	Type of study/ Quality rating	Methods	Limitations	Findings	Conclusions
Arroll, Fernando, Falloon, Warman & Goodyear-Smith, (2011)	Nonrandomized controlled trial SIGN=2-	Researchers sought to create and validate a new questionnaire to diagnose primary insomnia by excluding other causes in the primary care setting. A tool was developed, validated in patients >15 years old and audited by a specially trained psychiatrist.	The tools was validated in a private practice psychiatrist office and there was a small N=36 subsample of patients was chosen from the primary care setting to represent a spectrum of disorders. The CAGE questionnaire was used to exclude alcohol related sleep issues instead of AUDIT	Specificity was high for sleep disorders associated with mood disorders, OSA and delayed sleep phase disorder in the primary care setting.	The Auckland Sleep Questionnaire requires revision and validation in the primary care setting to be useful.

			questionnaire. The CAGE questionnaire has a high threshold for alcohol problems.		
Behar, Roebuck, Domingos, Gederi & Clifford, (2013)	Expert Opinion SIGN =4	This study explored 3 main functions used to assess sleep disturbance using the smartphone: questionnaire answers, actigraphy and audio recording	Review explored applications used by both consumers and healthcare professionals but did not differentiate.	-No existing sleep related application is based on strong scientific evidence with the exception of the applications that include a validated questionnaire.	Sleep health applications are abundant for use on the smartphone however use of the smartphone as a diagnostic medical device has not been validated, regulated or approved. Validated sleep questionnaires are available in a mobile platform.
Bochicchio et.al (2005)	Randomized controlled trial	12 first year trauma and critical care fellows were	Small test group and changes in testing results can	Improvement in baseline scores at 3 month and 6 month	PDA usage can assist with clinical decision making

	SIGN= 1-	separated into 2 groups. Six were given Blackberry PDAs with Johns Hopkins Antibiotic Guide installed and 6 fellows were not given PDAs. A pretest, 3 month and 6 month test was conducted to test knowledge of infectious disease management; accuracy was also assessed at these intervals.	possibly be attributed to increase in clinical knowledge vs impact of PDA usage for infectious disease management.	intervals among PDA group vs non PDA group. Antibiotic decision accuracy was improved from the 3 month to 6 month interval as well.	with antibiotic usage among fellows.
Buijink, Visser & Marshall, (2013)	Expert Opinion SIGN = 4	N/A	N/A	N/A	A majority of medical mobile applications are developed without medical professional input. Concerns about patient confidentiality,

					malfunctioning clinical decision making processes and conflict of interest are foremost. There is no peer review process for mobile applications, at this time there is only professional commentary on usability and content. Mobile applications need to be evidence based and updated to reflect the latest evidence based research.
Chai-Coetzer et.al (2011)	Non-randomized controlled trial SIGN =2-	A simplified screening tool (OSA50) was created based on the Berlin questionnaire and	-Patients that were high risk for OSA were integrated into the study groups to	OSA50 was significantly predictive of moderate to severe sleep apnea with AUC 0.84, (95%	The OSA50 shows promise for use in the primary care setting. There is some concern

		validated for use in the primary care setting. N=157 patients with 79 in the experimental group and 78 in the control group	test predictive value of the tool -Competing interest were identified by authors	CI 0.75 to 0.94, p< 0.001) 100% sensitivity (95% CI 86% to 100%), NPV of 100% (95% CI 73% to 100%)	about validity among the general population with unknown risk for OSA.
Charani et al. (2012)	Descriptive study SIGN=3	A mobile app version of the Imperial Antimicrobial Prescribing policy was developed for download by the physicians and pharmacists of 5 teaching hospital.	NPs and PAs were not included in this study. The researchers were exploring uptake of the mobile app versus impact of knowledge.	The app was downloaded by 40% of the junior physicians within the first month and 100% of the junior physicians by 12 months. 71 physicians and 16 pharmacists completed the pre-intervention questionnaire, 71% of physicians stated that the app improved their knowledge.	Given the wide usage of smartphones, delivery of clinical policy within mobile app format could be helpful.
Chung et al. (2008)	Non-randomized	This study was to validate the use of	Perioperative patients have a	211 patients had PSG; 205 patients did not	In perioperative patients, STOP

clinical trial SIGN= 2+	the STOP self-administered questionnaire to identify perioperative patients with OSA. 2467 patients were given the STOP questionnaire, 27.5% were suspected of being high risk for OSA. Those with positive scores were offered monitored overnight polysomnography (PSG) to confirm sleep apnea.	higher prevalence of OSA this tool has not been validated in other settings. The PSG technician was not blinded to the STOP scores	show at PSG. Of the 211 patients, 34 were used for pilot testing and 177 for validation, AHI was 20 =/- 6. Predictive parameters were >5 and > 15 and greater than 30 as cutoff Sensitivity 65.6%; specificity 60.0% PPV 78.4% and NPV 44.0%. With AHI >15, sensitivity 74.3% and NPV 76.0%. AHI>30 sensitivity 79.5% and NPV 89.3%. The sensitivity was increased if STOP was used in conjunction with BANG assessment	questionnaire in conjunction with BANG assessment was highly sensitive to patients with moderate to high risk of OSA.

Dee (2005)	Nonrandomized clinical trial SIGN= 2+	-Explored the use of PDAs among medical residents and attending physicians in patient care and their perceptions in 5 teaching hospitals in 5 states, Tennessee, Florida, Pennsylvania, Alabama and Kentucky -N=108; 59 attending physicians, 49 residents	Small study numbers in teaching hospitals	-87% used PDAs; 55% report frequent use, 32% occasional use; of frequent users 85% said PDAs influenced overall clinical decision making, 73% mentioned treatment alterations -60% of occasional users indicated that the PDA had influenced their overall clinical decision, 54% specifically mentioned a change to their patient's treatment plan -67% of all users reported that the use of the PDA influenced their clinical decision making	PDAs were used by residents and attending physicians in this study and the use of PDAs influenced clinical decision making and treatment plans in most cases.

				-no statistical significance in the number of residents and attending physicians using PDAs	
Divall, Camosso-Stefinovic & Baker, (2013)	Systematic Review SIGN=1+	Comprehensive literature review for research specifically: whether personal device assistants (PDA) use compared to the usual practice improves professional practice in terms of processes and outcomes of care. -Clinical decision support software (CDSS)/guidelines were loaded on PDAs for 5 of the studies.	-Small number of heterogeneous studies -Unable to obtain blinded studies as it is impossible to blind PDA usage -cost effectiveness and user acceptability were not reported	-Statistically significant positive benefit for clinical outcomes as CDSS seen in 3 studies - CDSS on PDAs vs other means found the PDA group identified more diagnoses than the control	PDA use with CDSS software can improve diagnosis however more studies are needed.

		-Control group was compared to non PDA users 7 articles were found to meet inclusion criteria			
Epstein et al. (2009)	Guideline for evaluation, management and long term care of obstructive sleep apnea in adults. AGREE II Overall:5 Scope and purpose:100% Stakeholder involvement:50%	The American Academy of Sleep Medicine Task Force developed guidelines for primary care providers and specialists for the evaluation and management of OSA in adult patients.	The guideline is thorough in evaluation and management however there is no evidence that the views and preference of the target population was sought, the method of systematic review was not fully described and external review was not discussed.	N/A	N/A

	Rigor of development:29% Clarity of presentation:72% Applicability:54% Editorial independence:67%		Facilitators and barriers of practice guidelines was not clearly described or potential resource implications.		
Gagnon, Ngangue, Payne-Gagnon & Desmartis (2015)	Systematic Review SIGN= 1+	33 research articles met inclusion criteria between 2000-2014	179 barriers identified. Organizational factors include management support, access and availability. Internal factors include ease of use, perceived usefulness, cost, privacy, time, interactions with others, risk-benefits assessment, familiarity with	A generic grid was used for adoption factors and some of the original factors were relabeled for classification purposes	The adoption of m-health technology is influenced by various factors however organizational support plays an important role in adoption as well.

			technology and security.		
Garrity & El Emam, (2006)	Systematic Review SIGN=1-	23 research articles were found meeting the inclusion criteria of: PDA usage in healthcare, articles published after 1993	-8 studies were nonacademic provided by internet research firms or physician groups known by the authors. -Articles were selected based on data collected between 1999 and 2004	-Adoption of PDA use was more likely in younger physicians <5 years out of residency, less than 45 years old. -Men were slightly more likely to adopt PDA use. Pediatricians had a high rate of use at 75% based on a survey conducted by the American Academy of Pediatricians in 2001 in the respondents less than 30 years old	PDA use among healthcare providers is varied among studies. The use of technology has outpaced research. By the time research has been conducted, a particular technology is either in practice or abandoned.
Goldbach et al. (2014)	Nonrandomized clinical study	This study was to compare the clinical knowledge of first year residents with the use of medical mobile applications	The web based resource, PubMed access was dependent on connectivity. There was a small	The residents utilizing the medical applications had more fully correct answers than those using the PubMed website (63%	Using PubMed abstracts and performing critical analysis is not as realistic as accessing mobile

		vs PubMed for Handheld abstracts	sample size of N=19 and the success of the study was based upon the users' ability to search the database	vs 13%, p<0.0001)	applications to answer clinical questions.
Grover et al. (2011)	Nonrandomized clinical trial SIGN= 2+	The purpose of this study was to compare the use of a Review of Systems form with 2 imbedded sleep questions to a standard verbal history by physicians to determine how effective a ROS form facilitated identification and investigation of patients with risk for OSA. The Berlin Questionnaire was used to assess risk of OSA among patients. Researchers also	Only 2 clinical sites investigated. Exclusion of NP and PA providers Administration of the Obstructive Sleep Apnea Knowledge and Attitudes Questionnaire indicated physician competence and knowledge about the importance of OSA screening however this may not be indicative	The ROS form had a sensitivity of 57% (95%, CI, 45-68) and specificity of 73% (95%, CI 65-79) for high risk OSA as compared to the Berlin Questionnaire. The use of the patient completed ROS increased patient documentation of sleep complaints versus verbal history only (31% vs 5%) however physicians infrequently addressed sleep complaints 2/3 of the patients that	Knowledge and attitudes about OSA as a health concern did not positively affect physician identification and investigation of sleep complaints. The two questions concerning sleep addressed in the ROS form were not sufficiently sensitive for sleep disorders.

		sought to see how often physicians in 2 clinical sites investigated sleep complaints	of the general medical population. No interrater reliability and the audits were not cross checked. This was not randomized or blinded.	indicated complaints did not have them addressed. There was no statistical significance between physician knowledge and attitudes and the rate of ordering sleep interventions.	
Guideline Development Group for the Management of Patients with insomnia in primary care (2009)	Clinical guideline AGREE II= Scope and Purpose=100% Stakeholder Involvement=100% Rigor of Development=100% Clarity of	Researchers reviewed 10 years of research to develop useful guidelines for the management of insomnia in the primary care setting.	Applicability needs to be addressed.	N/A	N/A

	Presentation=100% Applicability=54% Editorial Independence=100%				
Hayes, Murray, Castriotta, Landrigan & Malhotra, (2012)	Descriptive study SIGN=3	Researchers sought to use qualitative and quantitative data to determine the attitudes, perceptions and barriers to diagnosing and managing sleep disorders among two groups, generalists and specialist. Generalist N=165 and specialist N=12. Semi-structured interviews, discussion groups and online surveys	Only small number of specialist was minimal.	Thirty three percent generalist expressed hesitance to identify and manage OSA and shift worker disorders (SWD). Study participants lacked general knowledge and comfort with assessment and management of OSA and SWD. A majority of generalist viewed sleep labs with skepticism and did not view sleep medicine as a true medical	Generalists were not comfortable with identification or management of sleep disorders particularly OSA and SWD.

		were used.		specialty.	
Lamm, Poeschel, & Smith (2008)	Case study SIGN=3	Case study: 35 yo physically fit agricultural worker with fatigue, irritable mood and unexplained lower extremity pain. Labs were negative for autoimmune diseases. Cortisone injection and indomethacin stopped working. Referral to rheumatology and sleep medicine after patient revealed that wife complained of snoring and witnessed apnea.	N/A	Diagnoses rheumatoid syndrome and OSA. Methotrexate and nightly CPAP greatly improved his symptoms, mood and state of restfulness.	Primary care clinicians need to take a thorough history and screen patients for OSA even if body type and complaint are not congruent with sleep disorders. OSA can be the cause of depression, mood changes, anxiety and even treatment resistant pain.
Mickan, Tilson, Atherton, Roberts, &	Scoping Review of Systematic review SIGN=2-	5 systematic reviews were extrapolated from 506 studies to evaluate 4 areas of	-Scoping review of systematic reviews no primary studies, -	Physicians that used PDAs showed significantly lower prescription error rates	PDA use in clinical practice can positively affect patient

Heneghan, (2013)		handheld computer use: patient documentation, patient care, information seeking, and professional work patterns	Noted low quality studies -Researchers were unable to complete statistical data	(0.23 vs 0.45; P <.05) -improved practice efficiency, increased self- reported drug knowledge -75% of the users reported PDAs integrated into clinical flow well -Median patient encounter times decreased compared to paper.	documentation, patient care, patient outcomes, access to clinical knowledge and clinical work flow.
Mold, Quattlebaum, Schinnerer, Boeckman, Orr, & Hollabaugh, (2011)	Descriptive study SIGN=3	44 research-based practice facilities were chosen for descriptive analysis of OSA identification and referral. Six components were used to analyzed: semi-structured interviews with primary care	Over sampling of older adults as the study was partially funded by Medicare. This was a sample of practices already a part of a research network therefore these	30%-40% of patients are high risk for OSA however only 20% report their sleep problems to their PCCs. PCCs only refer those patients for PSG whom they are sure are positive for OSA. PCCs who reported referral	PCCs generally do not identify patients at high risk for OSA and most patients do not discuss sleep symptoms with their clinician. Among sleep specialists, PCCs still refer more

		clinicians and sleep specialist; medical record reviews of patients with and without diagnosed OSA, patient surveys from patients age 30-64 and age 65 < waiting to see the clinician.	clinicians may not be representative of other practices.	reported using review of systems questions and risk factors to determine who to refer to sleep specialist.	frequently then subspecialists and self-referrals.
Moore & Jaywardene (2014)	Descriptive Study SIGN = 3	Nurses and physicians were surveyed using Survey Monkey about use of smartphones in clinical practice	Sample was self-selecting nature due to the use of electronic survey so sample was limited to internet and email users	N=82 nurses and N=334 physicians surveyed. 58% nurses and 81% physicians used smartphones in clinical practice. 61% nurses used calculators and clinical decision tools and 73% physicians used calculators and clinical decision tools.	Of the MDs surveyed, physicians were more accepting of technology in the clinical practice while nurses preferred to use experienced colleagues, protocols and guidelines.
Ozdalga, Ozdalga & Ahuja, (2012)	Expert Opinion SIGN= 4	Research was sought to quantify the use of smartphones in	Internal medicine and surgical specialties were	There is a scarcity of high quality research evaluating the impact	The use of smartphones in medicine has not

		medicine. Inclusion criteria: smartphone, smart phone, mobile phone, iPhone, android, blackberry and windows mobile in combination with medicine. 60 articles were found and categorized by : patient care and monitoring, health apps for layperson, communication, education and research, and physician or student reference apps	excluded.	of smart phones in medicine. Ever changing technology directly	been fully researched.
Putzer & Park (2012)	Descriptive Study SIGN = 3	Survey distributed to 400 physicians in 2 community hospitals and 1 academic	Small sample size, only one region was surveyed and	There was a statically significant relationship between behavioral intention of	Smartphone use among physicians in this region is dependent on

		teaching hospital in South eastern US. 103 respondents returned surveys on user attitudes on toward smart phone use.	only physicians, nurse practitioners and physician assistants were excluded.	use and use of smartphones. Compatibility, job relevance and internal environment had higher impact than other variables beta value for compatibility (.71) for compatibility or the strongest relationship to beta value (.42) internal environment	organizational support, intent to use and the usefulness to clinical practice.
Rajpaul & Acton (2015)	Descriptive Study SIGN =3	Specially designed mobile app for pressure ulcer education delivery to 2 nursing home staffs.	Though the researchers report more than 1000 downloads no statistical analysis provided to validate the effectiveness of the mobile app.	Avoidable pressure ulcer free days increased from 100 days to greater than 200 days.	The specially designed mobile application seems to have had a positive effect on pressure ulcer education.
Rudin, Landorf, Macias, Oman, Kazzi (2006)	Randomized Clinical Trial	Emergency medicine residents n=18 and emergency medicine	Patient care outcomes were not measured. All	PDA usage changed patient care more than use of paper text	PDA usage can assist with patient management and

	SIGN= 1-	attendings n=12 were selected to use PDAs with drug and clinical references or paper text references. Researchers looked at information retrieval time, sources, changes to patient care among both groups.	text references were not readily available and physicians had to go to a separate area to obtain information. Specific clinical questions were not queried that prompted clinical inquiry. Hawthorne effect may have skewed results.	references (29.8% vs 17.6%) mostly in drug therapy. Information was retrieved more rapidly with PDAs. Emergency medicine residents used PDAs more than emergency medicine attendings.	provides quicker access to clinical references.
Schutte-Rodin, Broch, Buysse, Dorsey & Sateia (2008)	Clinical Guideline for the Evaluation and Management of Chronic Insomnia in Adults AGREE II= Scope and Purpose=100% Stakeholder				

	Involvement=100% Rigor of Development=100% Clarity of Presentation=100% Applicability=100% Editorial Independence=100%				
Schwartz, Roth, Hirshkowitz & Wright, (2009)	Expert Opinion SIGN=4	Researchers sought to offer a current assessment of sleep disorder prevalence, etiologies, assessment and treatment.	N/A	N/A	PCCs should incorporate a sleep history into the patient's medical history and include information from their bed partners. Self-reporting questionnaires can assist clinicians in assessing sleep habits: Epworth Sleepiness Scale, Stanford Sleepiness Scale,

					Karolinska Sleepiness Scale, Fatigue Severity Scale, Fatigue Questionnaire, Fatigue Impact Scale and Brief Fatigue Inventory
Senthilvel, Auckley, & Dasarathy (2011)	Non randomized prospective study SIGN= 1+	101 new patients were approached to complete sleep questionnaires (Cleveland Sleep Habit Questionnaire with embedded Berlin and Epworth Sleepiness Score questions and STOP questionnaire) after being seen for new patient evaluations. The results of their questionnaires were reviewed and EMR encounters were retrospectively	N/A	Overall documentation of sleep complaints was low, insomnia was the most common documented sleep complaint (20%) while 29% of the participants indicated insomnia on CSHQ. One patient was screened for snoring while 50.6% reported snoring on CSHQ. 32.7% of the patients were noted as high risk for OSA. The average time for	Sleep disorders are not routinely addressed by primary care providers in this study even with the additional time afforded with new patient examinations. A significant portion of patient-reported sleep complaints are going unaddressed. The use of a validated sleep tool can be

		reviewed for any documentation by the PCP concerning sleep complaints including HPI, ROS, physical examination, labs and referrals.		patients to complete the CSHQ was 302+/-97 seconds	beneficial in identification of sleep disorders in primary care.
Sorscher (2008)	Descriptive Study SIGN=3	Health history database forms were reviewed for 121 primary care clinics in the Twin Cities metropolitan area of Minnesota for questions related to sleep disorders. Four key elements were queried: questions related to insomnia, sleep disordered breathing, hypersomnia and parasomnia.	There was a high proportion of hospital/clinic systems and standardized patient care forms.	Only 14 distinct forms were identified among the clinics. 8/14 had no questions about sleep. Of the remaining 6 had 1-2 general sleep related questions. 1 had a set of questions listed in the respiratory section about sleep disordered breathing. 2 asked about insomnia and snoring and 1 asked about insomnia and nightmares. There was no symptom specific inquiry however a	The currently used health history forms and ROS do not address sleep disorders.

				check box was available for patients to indicate general issues with sleep. The ROS only included "fatigue" as a possible symptom for sleep disorders.	
Stroud, Smith, & Erkel, (2009)	Descriptive Correlation Study SIGN=3	126 randomly selected NPs from the members of the American Academy of Nurse Practitioners (AANP). Survey using a 27 item questionnaire related to PDA use, frequency, perceptions, and duration.	Limited sample, not representative of national sample, Only AANP members queried.	91% believed that PDAs supported clinical decision making, 82% believed PDA use promoted patient safety, 75% believed PDA use increased productivity. Electronic references like drug references, medical textbooks and practice guidelines were utilized most.	PDA use can be beneficial to clinical practice as diagnosis support. NP use of PDAs is comparable to physician counterpart use.
Yaman et al. (2015)	Descriptive Study SIGN=3	Survey was given to participants at a family medicine	The participation was limited to those that	The mean age was 35.7, 84 males and 92 females. 36.5%	Apps are used in clinical practices and smartphone

		conference to determine possession of smart devices, applications used, personal thoughts on applications and acceptability of medical apps	attended the family medicine conference which may limit access to other primary care providers such as nurse practitioners and physicians assistance.	reported that smartphones/tablets were important in daily lives, 24.4% suggested apps that might be useful for daily practice. The most useful apps noted were drug references, journals, evidence-based guidelines, picture atlases, prediction rules and medical calculators.	technology is useful in daily life.
Zozula, Rosen & Jahn, (2005)	Descriptive Study SIGN= 3	Researchers sought to evaluate the effects of an educational intervention program on recognition and referral for sleep disorders among health care clinicians in a community health center over a 4	Patients were lost from diagnosis to treatment. Multiple barriers were identified from clinician and patient perspective.	Pre-intervention referral 0.06% post intervention referral in the last year 0.21%; prevalence rate for sleep diagnosis increased similarly 0.11% vs 0.26%. Intervention only partially successful.	Educational intervention can help increase clinician awareness and appropriate referral however follow through is affected by not only clinician screening but

year period.

Ten 1 to 2 hour in-service trainings were provided to medical residents, attending physicians and healthcare staff over 4 years. Measurement criteria: referrals to the local sleep laboratory, a review of health care databases and patient chart review pre and post intervention.

patient compliance as well.

APPENDIX B

Chart Review Form

Provider 1 Provider 2	Sleep Quality Yes/no	Hours of Sleep Yes/no	Sleep Hygiene Yes/no	Sleep Medicine Yes/no	Sleep Medicine Referrals Yes/no
	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient A	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient B	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient C	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient D	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient E	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient F	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient G	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient H	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient I	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient J	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient K	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient L	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient M	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient N	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient O	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post

Patient P	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient Q	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient R	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient S	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient T	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient U	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient V	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient W	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient X	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient Y	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient Z	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient AA	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient BB	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient CC	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post
Patient DD	Pre Post	Pre Post	Pre Post	Pre Post	Pre Post

APPENDIX C

Demographics/Smartphone usage

Demographics: Smartphone Model used?

Most used mobile application(s): _____

Gender: Male Female

Job Title:

Current Job experience: <1 year 1-5 years 6-10 years 11-15 years 16-20 years 21-25 years 26 years and above

Total Working Experience

<1 year 1-5 years 6-10 years 11-15 years 16-20 years 21-25 years 26 years and above

APPENDIX D

ASKME Survey (Zozula et al., 2001)

1 The need for sleep decreases in persons above 50 years of age. FALSE

2 Melatonin is a natural body hormone that typically increases during nighttime hours. TRUE

3 More dream sleep (REM) occurs in the second half of the night. TRUE

4 Sleeping longer on weekends is recommended as a regular practice to make up for loss of sleep during the work week. FALSE

5 Newborn infants spend approximately 16—18 hours per 24-hour period sleeping. TRUE

6 The report of insomnia is twice as common in older men as in older women. FALSE

7 A young (pre-adolescent) child who regularly has trouble getting to sleep at night should be allowed to sleep later in the morning. TRUE

8 The typical age of symptom onset for narcolepsy is 40 years or older. TRUE

9 The ability to sleep increases in persons above 50 years of age. FALSE

10 Slow-wave sleep is more prominent in the second half of the night. TRUE

11 The amount of slow-wave sleep increases in persons above 50 years of age. FALSE

12 Episodes of sleepwalking tend to occur in the last third of the night. FALSE

13 Episodes of REM sleep tend to lengthen throughout the night. TRUE

14 Periodic limb movements during sleep are typically decreased in REM sleep. FALSE

15 Hyperactivity in children can be exacerbated by inadequate sleep. TRUE

16 In alcoholics in recovery, sleep normalizes within one month of alcohol abstention. FALSE

17 Daytime napping is recommended for patients with difficulty initiating sleep. FALSE

18 Weight loss is often indicated in the treatment of primary snoring or mild obstructive sleep apnea. TRUE

19 Slow-wave sleep is enhanced following daytime exercise. TRUE

20 Children who are chronic bedwetters respond to treatment with anticholinergic drugs. TRUE

21 Nightmares are more common within the first two hours of sleep. FALSE

22 Heart rate, respiration and blood pressure are more variable during REM sleep compared with non-REM sleep. TRUE

23 Antihypertensive drugs (e.g., beta-blockers) may cause sleeping difficulties as a side effect. TRUE

24 Early morning awakenings in the elderly are often associated with changes in the timing of their biological rhythms. TRUE

25 Alcohol can be beneficial in reducing the effects of jet lag. FALSE

26 Nightshift workers are more likely to fall asleep on the job compared with employees with regular, daytime hours. TRUE

27 Sleepwalking episodes commonly occur during REM sleep. FALSE

28 Menopausal women are at higher risk for developing symptoms of sleep apnea compared with pre-menopausal women. TRUE

29 Irregular sleep scheduling can increase the incidence of sleepwalking in children.

TRUE

30 Symptoms of narcolepsy are related to seizure activity in the brain. FALSE