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Screening the Commercial Motor Vehicle Driver for Sleep Apnea

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Abstract

The transportation industry has the third highest occupational risk for death and disability (BLS, 2010) with 7% of Commercial Motor Vehicle Drivers (CMVD) falling asleep while driving (NHTSA, 2006). One contributing factor may be undiagnosed Obstructive Sleep Apnea (OSA) (Tregear et al, 2009). In 2006, a Joint Task Force (JTF) published screening recommendations for OSA, which led to a change in the Department of Transportation screening practices within a local Occupational Medicine clinic.

The purpose of this study was to: (a) determine what percentage of drivers having had a positive clinical screening examination (met two of three objective measures) tested positive for a diagnosis of OSA (b) determine what percentage of drivers diagnosed with OSA had an Apnea-Hypopnea-Index (AHI) greater than or equal to 20 abnormal breaths per hour, meeting the threshold for mandatory treatment, (c) determine the relationship between Body Mass Index (BMI), hypertension and neck circumference with a diagnosis of OSA.

The electronic medical records of 182 drivers were reviewed. Of these, 143 were found eligible for the study with the following findings: 63% (n = 90) clinically screened positive and underwent confirmatory testing by Polysomnography (PSG). Of these, 92% (n = 83) were found to have OSA, and 48% (n = 43) met the threshold for mandatory treatment. The study found no correlation between a diagnosis of OSA and BMI. Hypertension was found to have an inverse relationship. Neck circumference was found to have a significant positive correlation. No drivers self-reported daytime sleepiness and would have been missed using the current recommendations. Screening the CMVD for OSA with self-reported symptoms of sleepiness is not adequate. This study shows the importance of neck circumference as the best predictor of identifying OSA.

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Introduction

The Federal Motor Carrier Safety Administration (FMCSA) was established within the Department of Transportation (DOT) on January 1, 2000, pursuant to the Motor Carrier Safety Improvement Act of 1999 (49 U.S.C. 113). The primary mission of the FMCSA is to reduce crashes, injuries and fatalities involving large trucks and buses **(**FMCSA, 2014c). CMVD are required by the DOT to undergo a periodic medical fitness examination when operating a commercial vehicle in interstate commerce that meets three major requirements: (a) has a gross vehicle weight of 10,001 lbs, (b) is used for the transport of 16 passengers (whether for compensation or not), and (c) transports hazardous materials requiring placarding (FMCSA, 2014a). The purpose of the medical examination is to detect any physical, mental, or organic conditions that may affect the ability of the driver to operate a commercial vehicle (FMCSA, 2014b). One component of the 13 physical qualifications for drivers in the medical examination is evaluation of a diagnosed or suspected sleep disorder. Obstructive sleep apnea is a respiratory dysfunction that may affect driver's alertness causing gradual or sudden incapacitation if the driver is drowsy or falls asleep (FMCSA, 2014b). It is a common sleep disorder and therefore the current focus for screening.

Project Purpose

In 2012, a clinical practice change occurred within the occupational health clinic that affected how the CMVD was screened for obstructive sleep apnea. At the request of a single motor carrier company, the organization changed the existing screening policy to follow the Joint Task Force (JTF) consensus screening recommendation's (Hartenbaum et al, 2006). Although not a requirement from the FMCSA, an employer may request additional screening beyond the DOT minimum for medical examiner to use. The purpose of this project is to determine if

consensus based recommendations are an effective method for screening and increasing identification of drivers with suspected or unrecognized obstructive sleep apnea.

Project Significance

Obstructive sleep apnea is a major contributor to sleepiness, a condition that could prove deadly for the commercial motor vehicle driver and passenger cars (Parks, Durand, Tsismenakis,Vela-Bueno, and Kales (2009); Tregear, Reston, Schoelles, and Phillips (2009). Parks et al. (2009) found obstructive sleep apnea to be a common health condition in the commercial driver, which if left untreated, has the potential to increase motor vehicle accidents by "two to seven fold" (p. 275).

Operating a large commercial motor vehicle is a multi-skilled task requiring a high level of physical, mental, and perceptual alertness (George, 2004). Drivers must be fully aware to critically analyze the surrounding area, make decisions quickly, and safely while maneuvering a large vehicle in difficult road conditions with limited road space (George, 2004). Due to the weight and size of a fully loaded truck or passenger bus the potential for destruction and harm is much greater than a passenger car (Donaghue and Labrum, 2014). Undiagnosed or untreated obstructive sleep apnea, a serious factor in motor vehicle accidents (Platt et al., 2013), may cause lack of attention and somnolence while driving (Platt et al, 2013).

This study is significant because it may take years to federally legislate sleep apnea assessment in the commercial driver population due to the recent passage of the Sleep Apnea Bill H.R. 3095 (detailed in the Federal Register section). The existing guidance is outdated, and recent recommendations are rescinded. The commercial driver medical examiner, using professional decision-making, is left questioning which consensus material has the most value

when determining the risk for motor vehicle accidents. The potential for serious and costly consequences may affect the commercial driver, the public and medical examiner equally (Strohl et al 2008; Boehlecke, B., 2008). It is essential that medical providers have the knowledge and tools necessary to carry out the screening accurately and effectively with application to all drivers equally when presenting to the clinic utilizing the best evidence available to support public safety and the mission of the FMCSA.

Current Screening Guidance

The current DOT medical screening guidance for commercial motor vehicle drivers that covers obstructive sleep apnea is in section 49 CFR 391.1 (b)(5) of the FMCSA regulations (see Appendix E). In this section, specific to the respiratory component of the medical exam, it states that the driver "has no established medical history or clinical diagnosis of a respiratory dysfunction likely to interfere with his ability to control and drive a motor vehicle safely" (FMCSA, p 4, section 5, 2014b)**.** However, the DOT does not have an absolute regulation on how the medical examiner should screen for respiratory conditions. The current guidance relies only on the patient's perception and self-reports of a health condition.

Available for the medical examiners to reference are two Federal Highway Administration Conference reports from a 1991 conference on Respiratory/Pulmonary Disorders and Commercial Drivers (FMCSA-Medical Reports Archive) and a 1998 conference on Neurologic Disorder's and Commercial Drivers (FMCSA-Medical Reports Archive). In 2000, FMCSA added a new question to the medical history form asking the driver to self-report: (a) a diagnosed sleep disorder, (b) pauses in breathing while asleep, (c) daytime sleepiness or (d) loud snoring, further identifying a potential sleep disorder (FMCSA, 2014b). The difficulty with self-reporting a symptom such as snoring is the lack of awareness or recognition of a disease process,

which may be interpreted as a normal health behavior by the driver. Additionally the driver may fear reporting due to a concern about potential job loss with diagnosis of obstructive sleep apnea.

Proposed Screening Guidance

To assist with the detection of obstructive sleep apnea a professional society Task Force, referred to as the Joint Task Force (detailed in the Review of Literature), published screening recommendations in 2006 to identify CMVD at high risk for obstructive sleep apnea (Hartenbaum et al, 2006). This Task Force included representatives of the American College of Chest Physicians (ACCP), the American College of Occupational and Environmental Medicine (ACOEM), and the National Sleep Foundation (NSF) (Hartenbaum et al, 2006). Following this publication in 2006 (detailed below), and challenged with the task of determining medical fitness, medical examiners requested updated guidance from the FMCSA (FMCSA, 2012). To address these concerns the agency directed its two advisory committees, the Motor Carrier Safety Advisory Committee and the Medical Review Board to meet and provide recommendations (FMCSA, 2012). In February 2012, the joint committee completed its consensus recommendations on obstructive sleep apnea and medical certification of the commercial motor vehicle driver (FMCSA, 2012). For the purpose of this study the Joint Task Force screening recommendations were utilized (detailed in the Measures section) (Hartenbaum, 2006).

The Joint Task Force recommended drivers have additional testing if they self-report a history of loud snoring, excessive daytime sleepiness, witnessed apneas, and or an Epworth Sleepiness Scale (ESS) score of greater than 10 (detailed in the Measures section and Appendix B), and a prior diagnosis or history of obstructive sleep apnea that is not adequately controlled. Additionally, they added recommendations for objective criteria including enlarged neck circumference, obesity and hypertension, which can be obtained through the history and physical

examination. The Task Force recommends further testing if the driver meets at least two of three objectively measured criteria (detailed in Appendix C).

Federal Register

On April 20, 2012, the Federal Motor Carrier Safety Administration posted the proposed updated guidance from the Medical Expert Panel for public comment on the Federal Registry (FMCSA, 2012). The American Trucking Association (ATA) voiced objections about the Department of Transportation attempting to update recommendations and enact changes through guidance. In September 2012, two U.S. Representatives Larry Bucshon (R, Ind.) and Dan Lipinski (D-Ill.) introduced legislation to regulate standards for sleep apnea screening and testing of professional drivers (ATA, 2013). As, ATA president and CEO Bill Graves said in an interview with PRNewswire,

> "ATA believes that if the Federal Motor Carrier Safety Administration wants to regulate sleep apnea, it should do so through the normal, established regulatory process rather than informal guidance. The rulemaking process allows for medical experts, the regulated community, including professional drivers, to provide valuable data and input for the agency to consider in developing its regulations. A formal rulemaking will also require an analysis of the benefits and costs of regulating sleep apnea, an analysis not required for the issuance of guidance." (ATA, 2013).

The proposed guidance was subsequently withdrawn effective April 27, 2012 (FMCSA, 2012). The legislation introduced by U.S. Representatives Bucshon and Lipinski was the Sleep Apnea Bill H.R. 3095, which became law on October 15, 2013 (H.R. 3095, 2013). The new

legislation ensures that any new or revised requirement by the Department of Transportation for sleep apnea be made by a formal rule making process and not guidance alone **(**H.R. 3095, 2013). The rule making process may take years due to time and fund appropriations required to do the analysis.

Epidemiology

Obstructive sleep apnea is a health condition known as a sleep-related breathing disorder. The condition involves a decreased or cessation of airflow with continued attempts to breath. Physiologically, muscles relax during the sleep period causing soft tissue in the back of the throat to collapse leading to a blocked upper airway (AASM, 2014). When this occurs, there is a partial reduction (hypopnea) or a complete pause (apnea) in breath for at least 10 seconds (AASM, 2014). Pauses can last for 10 to upwards of 60 seconds leading to decreased oxygen concentration in the blood (AASM, 2014). In more severe cases, oxygen levels can drop as much as 40 percent (AASM, 2008). The body's normal response to the lack of oxygen is to alert the body causing a brief arousal from sleep to restore normal breathing. Many persons with obstructive sleep apnea snore loudly with frequent episodes of silence when the airflow is decreased or blocked. Often persons make choking sounds, snorts or gasps for breath during sleep when trying to reopen the airway (AASM, 2014).

Obstructive sleep apnea is associated with reported symptoms of daytime sleepiness, decreased concentration and mood, headaches upon wakening, and snoring. Other symptoms may include nocturnal choking, unrefreshed sleep, fatigue, and observed pauses in breathing while asleep by a bed partner and nocturia (Gharibeh & Mehra, 2010; AASM, 2014).

Prevalence of Disease

It has been estimated that as many as 18 million Americans have sleep apnea including 17 to 28% of the commercial driving population (Pack et al, 2002; Talmage et al, 2008; Parks et al., 2009). Obstructive sleep apnea increased in 2014 to an estimated 25 million adults in the United States (AASM, 2014b). Peppard, Young, Barnet, and Hia (2013), estimates the current prevalence for moderate to severe OSA with episodes of absent or reduced breath greater than 15 events per hour are: (a) 10% among 30-40 year old men, (b) 17% among 50-70 year old men, (c) 3% among 30-49 year old women and (d) 9% among 50-70 year old women. These estimates of apnea have increased between 14-55% in keeping with the increase in overweight and obesity in the U.S. population (Peppard et al, 2013). Obstructive sleep apnea can occur at any age but prevalence increases during the middle and older years (AASM, 2008). Large segments of the adult population, between 80 to 90 percent are estimated to have sleep apnea and remain undiagnosed (AASM, 2008).

The DOT regulates all registered commercial motor vehicles that operate interstate or carry hazardous materials. As of December 2013, there were approximately 539,000 commercial motor vehicles with recent activity operating in the United States. Approximately 5.6 million commercial drivers operate in the United States, with a potential for 92,000 to 151,000 of these drivers having undiagnosed sleep apnea (FMCSA, 2014d). Smith et al., (2011) reported in an online self-assessment that 21% of commercial drivers reported falling asleep at stoplights. This is in contrast, to responses from a Behavioral Risk Factor Surveillance System, an on-going United States telephone health survey, where nearly 5% of the general population reported at least once in the previous 30 days, they had fallen asleep or nodded off while driving (CDC, 2012a).

Effects of Disease

The immediate effects of the disease are intermittent hypoxia, poor sleep, and fluctuating heart rhythm (Peppard et al, 2013). Decreased oxygen levels in the body can lead to decreased alertness, fatigue and impaired concentration (AASM, 2008). People with obstructive sleep apnea generally have an increase in cardiovascular disease, stroke risk and associated risk of increased impaired glucose tolerance and diabetes (Peppard et al, 2013; AASM, 2014). Untreated sleep apnea is a significant risk factor for developing hypertension independent of other conditions such as obesity and smoking (AASM, 2014). Lastly, there is an increased risk of injury and death related to an increase in motor vehicle accidents (Tregar et al, 2009).

Risk Factors

Several identified risk factors may predispose someone to obstructive sleep apnea. Key factors for the development of this health condition are obesity, large neck and narrow airway. Other risk factors include: aging, menopause, being male, and alcohol consumption. Associated risks are craniofacial abnormalities, and genetics. Aging is associated with increased upper airway resistance, increased parapharyngeal fat, decreased parapharygeal size, and impaired muscle reflexes (Gharibeh & Mehra, 2010). Menopause due to the changes in body fat distribution, decreased upper airway muscle tone and decreasing hormonal influences are also considered risk factors (Gharibeh & Mehra, 2010; Lee, Nagubadi, Kryger, Mokhlesi (2008). Obstructive sleep apnea is more common in men due to the difference in fat distribution. Men have more upper body fat including the neck and women have more lower body fat (Gharibeh & Mehra, 2010). Alcohol ingestion prior to sleep has shown to increase the upper airway collapsibility resulting in increased disruption of sleep (Gharibeh & Mehra, 2010; Punjabi, 2008).

Craniofacial abnormalities that alter the bony and soft tissue structure of the head and neck may increase the risk of having sleep apnea (Gharibeh & Mehra, 2010). Genetically, there is a higher prevalence in families suggesting a familial component (Gharibeh & Mehra, 2010; AASM, 2014). Obesity is a significant risk factor. Persons who are obese and morbidly obese have a higher prevalence of sleep apnea (Gharibeh & Mehra, 2010; AASM, 2014). Obesity has dramatically increased over the last 15 years in the United States, excess body weight is common in patients with obstructive sleep apnea (Lee et al, 2008). In 2013, there were approximately 154.7 million Americans age 20 years and older who were overweight or obese in the United States. Men accounted for 79.9 million with a body mass index greater than 25 and women accounted for 74.8 million (AHA, 2013). Excessive weight alters the upper airway by increasing parapharyngeal fat deposition resulting in a smaller airway and increased airway collapsibility, and reduction in lung volume. Clinically, excess body weight is present in more than 60% of sleep apnea patients (Gharibeh & Mehra, 2010; Lee et al, 2008; Punjabi, 2008).

Relevance to Population Health Outcomes

Sleep problems are common; 25 % of U.S. adults report inadequate or poor quality sleep or rest at least 50% of the time (Healthypeople.gov, 2014). Insufficient sleep or poor sleep health has been associated with high blood pressure, coronary artery disease, cognitive impairment and increased occupational injury (Peppard et al, 2013). Even mild and asymptomatic obstructive sleep apnea can produce sleepiness and place drivers at risk for increased motor vehicles accidents affecting the driver as well as other lives (Tregar et al, 2009).

Initiatives

Obstructive sleep apnea and the associated comorbid conditions can have a profound and costly impact on public health (Kapur, 2010). Increased public awareness and treatment of sleep

health can improve productivity, wellness, quality of life, and safety on roads and in the workplace (Healthypeople.gov, 2014). One goal of Healthy People 2020 is to reduce the rate of vehicular crashes due to drowsy driving from 2.7 to 2.1 per 100 million miles traveled. The American Academy of Sleep Medicine has collaborated with the Centers for Disease Control and Prevention to promote the National Healthy Sleep Awareness project educating the public that snoring is a warning sign of obstructive sleep apnea and encouraging adults to speak with their doctor (AASM, 2014b).

Theoretical Framework

Rosswurm's and Larrabee's (1999) theory of change supports this project. This theory recognizes that translation of research into practice requires a solid grounding in change theory, principles of research utilization, and use of standardized language. The model for evidence-based practice has the following six phases: (a) assess the need for change in practice by examining the current clinical screening practice of self-reported history compared to objective measures for obstructive sleep apnea; (b) link the problem with the interventions and outcomes by utilization of a Clinical Screening Tool to increase the recognition of obstructive sleep apnea through improved medical provider screening practices; (c) synthesize the best evidence by analytical review of the literature and research studies and utilization of the Joint Task Force screening recommendations; (d) design a change in practice with implementation of evidenced base care to improve patient outcomes; (e) implement and evaluate the practice change by adapting the Clinical Screening Tool for all commercial drivers presenting for the DOT medical examination; and (f) maintain change by continued use of the Clinical Screening Tool and referral of all commercial drivers meeting the screening criteria

Rosswurm's and Larrabee's conceptual framework (1999) provides a rationale for empowering clinicians in the process of evidence-based practice changes. This model was used to adapt the existing medical evidence-based practice to incorporate a focus on nursing phenomena with the goal of teaching evidence based nursing practice, while also evaluating the possibility of changing clinical practice (Rosswurm & Larrabee, 1999).

Review of the Literature

The keywords used to review the literature were obstructive sleep apnea and motor vehicle accidents, obstructive sleep apnea, and commercial drivers. The studies were reviewed to determine the prevalence of obstructive sleep apnea in the commercial driver population. The studies followed the screening recommendations from the Joint Task Force (detailed below) (Hartenbaum et al., 2006).

The Joint Task Force recommends: if the commercial driver meets two of three objectively identified criteria: (a) body mass index 35 kg/m^2 or greater, (b) neck circumference greater than 17 inches in men and greater than 16 inches in women, (c) hypertension (new, uncontrolled, or unable to control with less than two medications) (Hartenbaum et al., 2006). Additionally, if the driver reports on the Medical Examination form a sleep history suggestive of obstructive sleep apnea: (a) a sleep disorder, (b) pauses in breathing while asleep, (c) daytime sleepiness, or (d) loud snoring. The Joint Task Force recommends referring the driver for an in-lab sleep study also known as the polysomnography (PSG) (detailed in the Measures section).

Five studies reviewed indicated a high estimate of obstructive sleep apnea among cohorts of commercial drivers (Berger, 2012; Parks, 2009; Platt, 2013; Talmage, 2008; Xie, 2011). Talmage et al **(**2008) found of the 1,443 commercial drivers screened, 13% (*n* = 190) drivers

clinically screened positive by examination using the Joint Task Force recommendations. Of this 71% (*n* = 134) underwent testing with the in-lab sleep study and 29% (*n* = 56) refused testing. Of the 71% (*n* = 134) that had testing, 95% (*n* = 127) were confirmed to have obstructive sleep apnea and 5% (*n* = 7) were not using the gold standard Polysomnography (detailed in the Measures section).

Talmage et al (2008) found that neck circumference clustered from 17-18 inches, the Epworth Sleepiness Scale scored 3-4 (range 0-24) (detailed in the Measures section) and hypertension was found in 40-60% of drivers diagnosed with moderate to severe obstructive sleep apnea. The most interesting findings were that none of the drivers would have been diagnosed if using the self-reported screening question on the current Medical Examination form by itself.

Parks et al (2009**)** found among 456 drivers in an occupational health clinic, 17% (*n* = 78) met the clinical screening exam recommendations of the Joint Task Force. Of this, 68% (*n* = 53) were referred for a sleep study and 32% (*n* = 25) were not due to examiner discretion. Of these, 62% (*n* = 33) were lost to follow up leaving 38% (*n* = 20) of drivers accepting the voluntary testing. Of the 20 remaining drivers referred and tested, 20 were found to have a diagnosis of obstructive sleep apnea, supporting a high positive predictive value. The other 33 drivers that were lost to follow up showed no significant difference from those confirmed to have obstructive sleep apnea.

Platt et al (2013) screened 265 drivers, 14% (*n* = 36) were excluded for not meeting inclusion criteria, 35% (*n* = 92) declined to participate, leaving 52% (*n* = 137) drivers. Of the 137 drivers enrolled in the study, 24% (*n* = 33) failed to follow up for testing. Of the remaining 76% (*n* = 104) drivers, four failed the sleep study, which was not repeated. Of the remaining,

73% (*n* = 100) drivers successfully completed the sleep study with more than half (53%) found to have a diagnosis of obstructive sleep apnea and showing disease severity (AHI-detailed in the Measures section) of 20 or more episodes of absent or decreased breaths per hour, which is the required threshold for treatment. Using the current medical examination report form only 11% of the 100 drivers self-reported symptoms of sleepiness.

Berger et al (2012) conducted an employer mandated on-line screening for obstructive sleep apnea. The screening differed from Talmage (2008) and Parks (2009), in that a medical provider conducted no physical examination. The on-line screening found among 19,371 Commercial Drivers, 30% (*n* = 5,908) were at higher risk. To date, 36% (*n* = 2,103) of drivers were sent for a sleep study (detailed in the Measures section) with 21% of these confirmed positive for a diagnosis of sleep apnea.

Xie et al (2011) conducted a medical records review and found among 1,833 drivers with no history of obstructive sleep apnea, 11% (*n* = 192) clinically screened positive. Of these, 60% (*n* = 127) failed to follow up and the remaining 79% (*n* = 51 of 65) were found positive for a diagnosis of obstructive sleep apnea after undergoing a sleep study. The study found only 3% (*n* = 50) self-reported a history of sleep condition.

Cost of Crashes

In 2012 there were 89,000 large trucks and buses involved in injury crashes with 126,000 people injured. There were 3,702 fatal crashes with 4,183 fatalities involving large trucks or buses, a five percent increase from 2011 (FMCSA, 2012d). The cost of police reported commercial motor vehicle crashes in 2011 totaled $87 billion dollars, of this $39 billion was attributed to fatal crashes, $32 billion to injury crashes and $16 billion to property damage only crashes (USDOT, 2013).

Joint Task Force

The JTF is a professional tri-society group composed of the American College of Chest Physicians (ACCP), the American College of Occupational and Environmental Medicine (ACOEM), and the National Sleep Foundation (NSF) (Hartenbaum et al, 2006). The ACCP is a medical specialty society of physicians, surgeons, allied health professionals, and individuals with PhD degrees who specialize in diseases of the chest and sleep disorders (ACCP, 2014). The NSF is an independent nonprofit organization dedicated to improving public health and safety by achieving understanding of sleep and sleep disorders, including sleep apnea (NSF, 2014a). The ACOEM is an international society of 4,500 occupational physicians and other health care professionals (to include Nurse Practitioners), providing leadership to promote optimal health and safety of workers, workplaces, and environments. The ACOEM professionals' are trained in preventing illness and injury in the workplace, and in helping patients return to work (ACOEM, 2014). The Joint Task Force is important because they created the tool with objective criteria that has a high predictive value for Obstructive Sleep Apnea diagnosis.

Summary of Literature Review

Commercial motor vehicle accidents remain a major occupational health and economic issue. Many of these accidents could be related to drowsiness or lack of attention while driving which may be attributable to obstructive sleep apnea. The reviewed studies show significant problems in the current screening process. Overwhelmingly, a large number of drivers lack recognition of or fail to report symptoms of sleepiness. The lack of confirmatory tests and return to the medical examiner following referral for a sleep study (PSG-detailed in the Measures section) reveals a significant gap in the screening and subsequent diagnostic process. In addition, more than half of the drivers failed to return to the medical examiner following the screening

examination because there was no mandated requirement to do so (Berger, 2012; Parks, 2009; Platt, 2013; Talmage**,** 2008; Xie 2011). The studies show a high predictive value upward of 80% with application of the Clinical Screening Tool using objective criteria recommended by the Joint Task Force with confirmation of the apnea diagnosis by a sleep study. These studies confirm that the Epworth Sleepiness Scale (detailed in the Measures sections) is not adequate to identify sleep apnea in a commercial driving population with few to none reporting sleepiness.

Clinical Application and Need for the Study

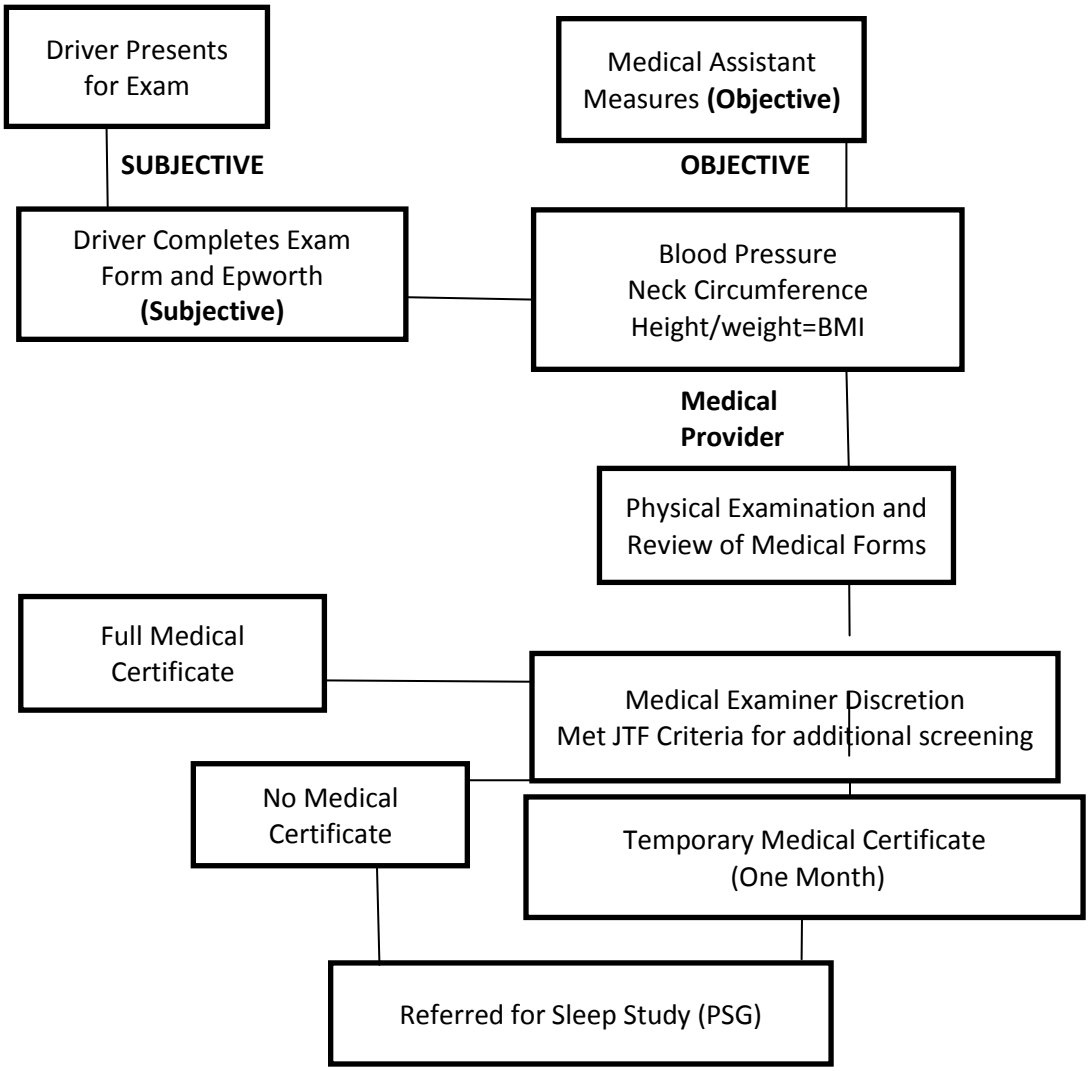
All commercial drivers in the United States are required to complete a medical examination every two years in order to maintain their license. Drivers with a diagnosis of sleep apnea and other chronic diseases are required to renew every year**.** During this required medical examination, the commercial driver presents to the occupational medicine clinic and completes the Medical Examination Report Form for Commercial Driver Fitness Determination (Appendix D). The driver self-reports his/her medical history and demographic information onto the form. The driver self-reports daytime sleepiness onto the Epworth Sleepiness Scale (detailed in the Measures section). The medical assistant measures the driver's blood pressure, height and weight and then calculates the body mass index. The medical assistant then measures the driver's neck circumference with an elastic tape measure and records all findings onto the Clinical Screening Tool.

The medical examiner reviews the medical history form with the driver, then reviews the measures obtained by the medical assistant and performs a physical examination on the driver. The medical examiner, after review of the information and physical exam, determines if the driver meets the Joint Task Force criteria (see Measures section) for additional screening for sleep apnea. Drivers with suspected sleep apnea are issued a temporary medical certificate of

clearance or denied a medical certificate and referred for an in-lab sleep study (PSG-detailed in the Measures section). The medical clearance is reviewed after the sleep study results are provided to the medical examiner for decision making and extended medical clearance. The driver requires medical intervention if the results of the sleep study showed an AHI (Apnea-Hypopnea-Index-detailed in the Measures section) greater than or equal to 20 abnormal breaths per hour.

The aim of this study is to demonstrate that subjective self-reported measures alone are inadequate to screen the commercial driver for suspected obstructive sleep apnea. A second aim is to show the effectiveness of adding objective criteria to the examination process for a suspected obstructive sleep apnea condition with the goal of diagnosis through an in-lab sleep study. Figure 1 is a diagram describing the clinic process from the time the driver presents for the DOT examination through the medical examination.

Figure 1. Clinic Process



Research Questions

1. What percentage of drivers having had a positive clinical screening examination (met two of three objective measures) tested positive for a diagnosis of obstructive sleep apnea?

2. What percentage of drivers diagnosed with obstructive sleep apnea had an Apnea-Hypopnea-Index (AHI) greater than or equal to 20 abnormal breaths per hour, meeting the threshold for mandatory treatment?

3. What is the relationship between body mass index, hypertension and neck circumference with a diagnosis of obstructive sleep apnea?

Methodology

Plan of Study

This was a retrospective, exploratory and correlational study. The project was designed to determine if the implementation of a Clinical Screening Tool (detailed in the Measures section and Appendix B) with objective measures would increase detection of drivers with obstructive sleep apnea compared to subjective, self-reported symptoms of sleepiness alone. The investigator reviewed, analyzed and interpreted 143 electronic medical records of commercial drivers presenting to three occupational medicine clinics for the DOT medical exam. The record assessment included: self-reported history of sleepiness, objective physical characteristics obtained from the medical examination, sleep study results and demographics (detailed below in Measures section).

The study was designed to determine: (a) how many commercial drivers having had a positive clinical screening examination (met two of three objective criteria which included body mass index, hypertension, or neck circumference), tested positive for a diagnosis of obstructive

sleep apnea (b) how many commercial drivers diagnosed with obstructive sleep apnea had disease severity greater than 20 (measured by the AHI detailed in the Measures section), meeting the threshold for mandatory treatment, and (c) the relationship between a diagnosis of obstructive sleep apnea with body mass index, hypertension and neck circumference.

Setting and Sample

The setting for this project was an occupational medicine practice in the mid-west with three clinic locations that are part of a larger healthcare system. The sample subjects were commercial drivers from a single transportation company who underwent the mandated DOT medical examination utilizing the addition of the Clinical Screening Tool. The subjects were obtained from the Electronic Medical Record (EMR) search from January 1, through December 31, 2012 of drivers presenting for the DOT medical examination.

Protection of Human Subjects

Permission to begin the project was first obtained from the Vice President of the research site where the data was stored since the company did not have an Institutional Review Board (IRB). Permission was then obtained from the IRB of the University of Missouri-St. Louis before data collection began. This study involved the use of existing data from the EMR of drivers that underwent the DOT medical examination. The investigator only reviewed the section of the medical record that pertained to this study. All information has been reported in aggregate fashion; individual subjects are not identifiable in the report. Data was de-identified by eliminating any potentially identifying information and assigning the subject a unique numerical identifier.

Procedure for Data Collection

The data were collected using a retrospective review of charts within an electronic medical records system. This was a pilot study looking at drivers with a high risk for obstructive sleep apnea. The investigator contacted the system analyst at the research site requesting records retrieval. The systems analyst provided the names of 182 drivers meeting the study criteria as follows: (a) a commercial driver that presented only one time for the Department of Transportation medical examination between January 1st, 2012 through December 31st, 2012, (b) the driver was employed by a single transportation company that requested application of the Clinical Screening Tool and, (c) the driver was issued a one month or less medical clearance, indicating a need for further medical evaluation.

The data from 182 records were de-identified by assignment of a unique numerical identifier. The patient name and unique identifier were transcribed onto a master list, and locked in a file at the research site, to which only the investigator had access. Subjects were completely anonymous; no information stored for analysis can be directly linked back to the patient record. No personal or medical information was directly linked to a patient name.

The study was designed to assess the effectiveness of a Clinical Screening Tool to detect drivers at higher risk for obstructive sleep apnea. Therefore, drivers with a prior history of having sleep apnea were excluded from the study. Other exclusions included: (a) did not meet the clinical screening criteria (having met two of three objective criteria-detailed in the Measures section), (b) lost to follow up, (c) excluded for other health conditions that would of themselves be disqualifying such as cardiovascular instability, uncontrolled diabetes or blood pressure greater than or equal to 180/110. The remaining drivers were divided into two groups. The first group consisted of drivers testing negative for a diagnosis of obstructive sleep apnea with disease

severity of less than five abnormal breathing events per hour (determined by the AHI-detailed in the Measures section). The second group of drivers were those that had a positive diagnosis for obstructive sleep apnea with disease severity of greater than or equal to five abnormal breathing events per hour (from the AHI-detailed in the Measures section). The latter group required mandatory treatment for OSA.

Demographic data collected were age and gender. Biophysical characteristics collected were; body mass index, blood pressure, neck circumference, and sleep study result (described in Measures section below). The investigator entered the de-identified data manually into an Excel spreadsheet. At the completion of the data collection, the de-identified data were then transferred to a secured flash drive for statistical analysis by SPSS Statistics, Version 22. The analysis was conducted with assistance from the University of Missouri-St. Louis, College of Nursing Senior Research Assistant.

Measures

Self-Reported History (subjective measure)

The driver was asked to report the following conditions on the medical examination form: (a) a past or current history of a sleep disorder, (b) pauses in breathing while asleep, (c) daytime sleepiness or, (d) loud snoring. Additionally, the driver reported any at-fault commercial motor vehicle accidents related to sleepiness or a witnessed apnea. For this study, the investigator reviewed the medical exam history form completed and signed by the driver and recorded findings onto the Excel spreadsheet.

Epworth Sleepiness Scale (subjective measure)

The Epworth Sleepiness Scale (ESS) is commonly used in the field of sleep medicine. It is a simple, self-administered eight-item questionnaire (see Appendix A). The tool was developed to measure self-reported daytime symptoms that persisted from week to week for clinical patients. Each item is scored from 0-3 describing recent patterns of dozing or chances of falling asleep. Scores can range from 0-24 on the 8-item questionnaire. A sum of greater than ten can indicate excessive sleepiness in clinical populations and consideration should be given for additional evaluation (Johns, 1991). For this study, the driver completed the 8-item questionnaire prior to the examination; questions were clarified by the medical examiner as part of the clinic protocol. The investigator reviewed the hand scored questionnaire signed by the driver, included it as part of the medical record and recorded the findings onto the Excel spreadsheet.

Neck Circumference (objective measure)

Neck circumference has shown to be a predictor of obstructive sleep apnea (AASM, 2014). It has been observed that persons with obstructive sleep apnea tend to have a shorter and fatter neck than those without. Obesity may contribute to a large neck due to the weight proportion of fatty tissue (Katz et al, 1990). As weight increases, the neck circumference gets thicker. The increased level of fat in the posterior throat causes a narrowing of the airway, which increases the risk for blockage (AASM, 2010). Men with a neck circumference greater than 17 inches and females greater than 16 inches are at greatest risk for obstructive sleep apnea (Hartenbaum et al, 2006). For this study, neck circumference was obtained by the medical assistant during the examination using an elastic tape measure and recorded on the Clinical Screening Tool. The investigator reviewed this documentation in the EMR and recorded the findings onto the Excel spreadsheet.

Body Mass Index (objective measure)

Body Mass Index (BMI) is a measurement that standardizes the height to weight ratio. Calculating the index is the first step to determine the degree of obesity. BMI is expressed as weight in kilograms divided by height in meters squared (kg/m2). Calculation of the BMI is commonly used to classify overweight (BMI of 25.0-29.9), obesity (BMI greater than or equal to 30.0), and extreme obesity (BMI greater than or equal to 40.0) (CDC, 2012b). Adults with a BMI greater than 30 have been found to have an increase in obstructive sleep apnea, the severity of disease increases with amount of excess weight (Lee et al, 2008; AASM, 2014). The Joint Task Force uses the cut-off point of BMI greater than 35 for identifying higher risk of sleep apnea (Hartenbaum, 2006). For this study, the medical assistant measured and then entered the drivers' current height and weight into the electronic medical record, which then calculated the BMI. The BMI was than transcribed onto the Clinical Screening Tool by the medical assistant. The investigator reviewed and recorded the findings onto the Excel spreadsheet.

Hypertension (objective measure)

Hypertension is the amount of fluid pushing against the walls of the arteries that carry oxygen in the body. There is an associated risk between obstructive sleep apnea and cardiovascular indicators such as high blood pressure and heart failure (National Sleep Foundation, 2004). It has been estimated that between 30-40% of adults diagnosed with obstructive sleep apnea have high blood pressure **(**AASM, 2014**).** During sleep apnea episodes when breathing is compromised, oxygen levels drop and the brain instinctively sends a signal telling the blood vessels to tighten up in order to increase oxygen to the heart and brain resulting in high blood pressure (National Sleep Foundation, 2004*).* For this study, the medical assistant using an electronic sphygmomanometer obtained the blood pressure measures twice. There is no

record reporting how far apart in minutes the blood pressure was retaken by the assistant. The results were then hand written onto the medical examination form as well as the Clinical Screening Tool. The investigator retrospectively reviewed both the Clinical Screening Tool and the Medical Examination form to ensure accuracy of recording. If the numbers were different, the investigator recorded the lower of the two readings onto the Excel spreadsheet.

Polysomnography, In-lab Sleep Study (objective measure)

Objective testing for apnea can be conducted in the home with a home sleep test or in a sleep center under observation of a sleep technologist. The current gold standard for diagnosing and determining severity of obstructive sleep apnea is the in-laboratory, technologist attended Polysomnography (PSG), also described as an attended or in-lab sleep study. The PSG measures brain waves, airflow, heart rate and rhythm, and respiratory effort. It also records eye movements, limb movements and oxygen in the blood (AASM, 2014a). During an over-night attended sleep study, a sleep technologist observes and monitors these measures. The collected data were reviewed and interpreted by a physician to make a diagnosis of obstructive sleep apnea using the Apnea-Hypopnea-Index as a reference (AASM, 2014a). For this study, the investigator reviewed the sleep study results from the sleep lab, which indicated disease or no disease, based on the gold standard testing method, and recorded the findings onto the Excel spreadsheet. The following measures of abnormal breathing events are obtained from the in lab sleep study:

(a) Episodes of Apnea (objective measure)

Apnea is the temporary cessation of breathing and therefore, of the body's intake of oxygen and release of carbon dioxide. It is a serious symptom, especially in patients with other potentially life-threatening conditions (Venes, 2013).

(b) Episodes of Hypopnea (objective measure)

Hypopnea is a respiratory disorder that involves a decrease in rate and depth of breathing in an individual **(**Venes, 2013).

(c) Episodes of Apnea-Hypopnea-Index (objective measure)

At the completion of the Polysomnography, also known as the sleep study, the data is reviewed to determine the Apnea-Hypopnea-Index (AHI), which is commonly used to establish the objective diagnosis of obstructive sleep apnea (Hartenbaum et al 2006 p. S6). AHI is defined as the sum of apneas and hypopneas divided by the hours slept (Hartenbaum et al 2006 P S6; AASM 2014). The Apnea-Hypopnea-Index (AHI) measures disease severity. Mild obstructive sleep disease is measured by an AHI between 5-15 abnormal breathing events per hour, moderate obstructive sleep disease is an AHI between 15-30 abnormal breathing events per hour and severe sleep disease is an AHI greater or equal to 30 abnormal breathing events per hour (AASM, 2008).

For this study, the certified sleep lab obtained the Apnea-Hypopnea-Index for each participant. A physician then interpreted the results and made a diagnosis if indicated, and a medical report was faxed to the occupational medicine clinic for scanning and storage in the drivers' medical record. The investigator reviewed the report findings and manually entered the AHI onto the Excel spreadsheet.

Clinical Screening Tool (known within the clinic as the DOT Sleepiness Risk Assessment Tool)

The DOT Sleepiness Risk Assessment Tool (Appendix B) used in this study for the detection of a sleep disorder was adopted by the Occupational Medicine clinic that was the site for this clinic. The tool was created based on recommendations from the Joint Task Force Consensus Recommendations (see Appendix B). The assessment tool was used as a worksheet

by the Occupational Medicine clinic for the detection of commercial drivers at higher risk for obstructive sleep apnea. The Task Force recommended referring a driver for additional screening if two of three objective criteria are met: (a) body mass index 35 kg/m^2 or greater, (b) neck circumference greater than 17 inches in men and greater than 16 inches in women, and (c) hypertension (new, uncontrolled, or unable to control with less than two medications) (Hartenbaum et al., 2006). The blood pressure cut off for this study was equal or greater to 140/90. In addition, subjective measures of sleepiness were assessed (detailed in the Measures section). When the driver self-reports on the Medical Examination Form a sleep history suggestive of obstructive sleep apnea; a sleep disorder, pauses in breathing while asleep, daytime sleepiness, loud snoring or an Epworth Sleepiness Scale greater than or equal to ten (detailed in the Measures section and Appendix C), referral for additional objective assessment is recommended.

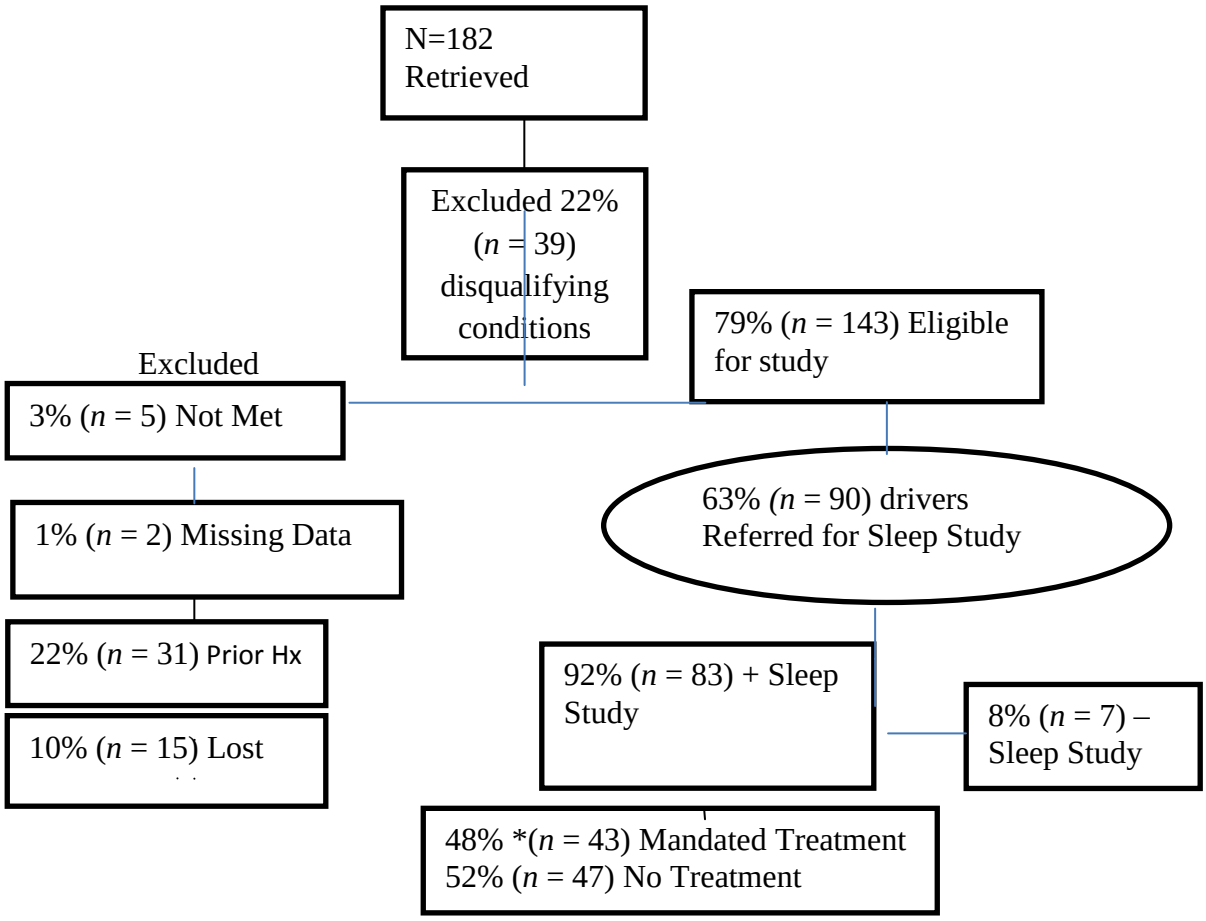
Results

Sample

One hundred eighty-two electronic health records from January 1, 2012 to December 31, 2012 were reviewed. Of the 182 records, 39 (21%) were excluded for disqualifying health conditions such as cardiovascular instability, uncontrolled diabetes, or blood pressure greater than or equal to 180/110. Of the remaining 143 drivers, 31 (22%) were excluded for prior history of obstructive sleep apnea (detailed in the Procedure for Data Collection section). Of the remaining 112 records, five (3%) were excluded for not meeting the clinical screening cut-offs (having met two of three objective measures recommended by the Joint Task Force). Two (1%) were excluded for missing data. Of the remaining 105 records, 15 (10%) were excluded due to loss of follow up, leaving 90 (63%) commercial drivers for final evaluation. Of the remaining 90

participants, none of the drivers self-reported symptoms of sleepiness or had an Epworth Sleep Score above ten (detailed in the Measures section). Of the 143 drivers, 90 (63%) were included in the final analysis and referred for confirmatory testing by Polysomnography or in-lab attended sleep study. These drivers would have otherwise been missed using the existing screening criteria of self-reported symptoms of a sleep disorder. Figure two is a diagram detailing the subjects that were reviewed in this study.

Figure 2. Study Subjects



Data Analysis

The study sample consisted of 26% (*n* = 23) females and 74% (*n* = 67) males. The mean age of the commercial driver was 46 years with a standard deviation of 10.3. The mean Epworth was 1.73 and the standard deviation was 0.872. No driver self-reported a sleep disorder, pauses in breathing while asleep, daytime sleepiness, or loud snoring. The investigator ran descriptive and correlational analyses using IBM SPSS Statistics Data Editor Version 22. The data analysis addressed the following questions:

Research Question 1. What percentage of drivers having had a positive clinical screening examination (met two of three objective measures) tested positive for a diagnosis of obstructive sleep apnea?

The investigator ran a descriptive analysis comparing drivers with a sleep study result of less than five abnormal breaths per hour indicating no sleep apnea to those greater than or equal to five abnormal breaths per hour indicating a positive finding of obstructive sleep apnea (detailed in Measures section). Of these drivers, 8% (*n* = 7) were found not to have obstructive sleep apnea and 92% (*n* = 83) were found to have a diagnosis of obstructive sleep apnea. For this study, the driver received a diagnosis of obstructive sleep apnea if the Apnea-Hypopnea-Index was greater than or equal to five abnormal breaths per hour (detailed in the Measures section). Diagnosis of apnea is determined by the severity of disease. This study found: (a) 31% of (*n* = 28) drivers with mild sleep apnea (measuring between 5.0-14.99 abnormal breaths per hour), (b) 41% (*n* = 37) of drivers with moderate sleep apnea (measuring between 15.0-29.0 abnormal breaths per hour), and (c) 20% (*n* = 18) of drivers with severe sleep apnea (measuring at greater than or equal to 30 abnormal breaths per hour).

Research Question 2. How many commercial motor vehicle drivers diagnosed with obstructive sleep apnea had an Apnea-Hypopnea-Index greater than or equal to 20 abnormal breaths per hour meeting the threshold for mandatory treatment?

The investigator ran a descriptive analysis comparing drivers with sleep study results less than 20 abnormal breaths per hour (AHI) to those equal or greater than 20 abnormal breaths per hour (AHI). Of these 63% (n = 90) drivers met the clinical screening criteria (having met two of three objective measures) 48% (n = 43) met the threshold for mandatory treatment and 52% (n = 47) did not meet the threshold required for treatment.

Research Question 3. What is the relationship between body mass index and a diagnosis of obstructive sleep apnea?

In order to test the relationship between body mass index and a diagnosis of obstructive sleep apnea, a Pearson correlation was calculated. The calculation found no significant association between a diagnosis of disease and body mass index.

Research Question 4. What is the relationship between hypertension (using systolic and diastolic blood pressure as a measure) and a diagnosis of obstructive sleep apnea?

In order to test the relationship between a diagnosis of obstructive sleep apnea and systolic and diastolic blood pressure, a Pearson correlation was calculated. Systolic blood pressure was found to have an inverse relationship of -.235 and was significant at the .01 level. Diastolic blood pressure was not found to have a significant relationship.

Research Question 5. What is the relationship between neck circumference and a diagnosis of obstructive sleep apnea?

To test the relationship between neck circumference and obstructive sleep apnea a Pearson Correlation test was calculated. The calculation found a correlation of .275 significant at the 0.01 level (2-tailed).

Summary of Results

The study found 63% (n = 90) of drivers clinically screened positive using objectives measures and of those 92% (n = 83) were diagnosed with obstructive sleep apnea. These drivers would have otherwise been missed using the current criteria of subjective measures alone. Close to half of the drivers, 48% (n = 43) required mandatory treatment following the FMCSA advisory board recommendations. The study found no correlation between a diagnosis of obstructive sleep apnea and body mass index or diastolic hypertension. Systolic hypertension was found to have a significant inverse relationship. Neck circumference was found to have a significant positive correlation further supporting adoption of this measure to screen the commercial driver for sleep apnea**.** Neck circumference is the best predictor of obstructive sleep apnea.

Stakeholders

The key stakeholders of this project include the commercial driver who presents for the annual Department of Transportation medical certification, the certified medical examiner performing the examination, the private companies that employ the driver, and the occupational medicine clinic. Other stakeholders include the families of the drivers affected financially from testing and diagnosis, sleep centers performing the testing, and the insurance companies paying for the testing and supplies.

Others involved in the operations are the medical director, responsible for the leadership and care provided by the individual medical providers, the clinic director, who directs the clinic staff and has the responsibility of responding to Client Company and driver concerns. The primary care provider who manages the driver's disease is a stakeholder. The public, sharing the highways and roadways with the commercial drivers, are stakeholders due to accidents and potential fatalities. Occupational Medicine organizations that represent and provide guidance for the profession are stakeholders in the findings of a sleep apnea project.

Outcomes

The short-term outcome for this project is the application of the Clinical Screening Tool (Appendix C) for identification of drivers meeting the Task Force consensus recommendations for additional screening if meeting two or more risk factors for Obstructive sleep apnea (Appendix C & D). For this project the Joint Task Force recommendations are; (a) Body Mass Index 35 kg/m^2 or greater, (b) neck circumference greater than 17 inches in men and greater than 16 inches in women, (c) hypertension (new, uncontrolled, or unable to control with less than 2 medications), (Hartenbaum et al., 2006). The driver self-reports on the Department of Transportation medical examination form a sleep history suggestive of obstructive sleep apnea, or an Epworth Sleepiness score greater than ten (detailed in the Measures section). An intermediate outcome for this project is the referral of the commercial driver for objective testing and identification of drivers with Apnea-Hypopnea-Index greater than 20 abnormal breaths per hour (detailed in the Measures section). The long-term goal of this project is to develop a continuous high quality-screening program.

Limitations

This was a pilot study looking at high risk drivers within a single transportation company. The sample size was small with little variation in characteristics between subjects due to the high risk population. Limitations of the study included inability to verify the reliability of the data that was hand written on the Clinical Screening Tool. The investigator did not directly collect the data and the study relied on others who collected and entered the data into the EMR. Due to limitations of the electronic medical record, it was not possible to electronically search for the individual variables for the study. The investigator was the only one who reviewed the medical records and recorded the data so reliability could not be assessed. The investigator manually entered the data into the Excel spreadsheet, which was not verified for accuracy by another investigator. In this study 10% (n = 15) were lost to follow up so it is unknown if they would have been diagnosed with Obstructive Sleep Apnea.

Discussion

In summary, the study shows subjective reports of sleepiness are inadequate with none of the drivers reporting sleep symptoms on the Medical Examination Form. The Epworth Sleepiness Scale is ineffective for screening for obstructive sleep apnea in this population with a low mean of 1.73 and restricted standard deviation of 0.9. None of the drivers scored above 10, which is the cut-off for referral and diagnostic testing based on JTF recommendations. The clinical screening with objective criteria found 92% (n = 83) of drivers that would have been missed if using the current guidance of subjective measures alone or the current FMCSA medical evaluation form. Of these, 48% (n = 43) met the threshold for mandated treatment. Additionally, 52% (n = 47) tested positive for a diagnosis of obstructive sleep apnea but did not meet the threshold for treatment; however they will require annual monitoring due to having the disease.

This study found a moderate correlation of .28 between a diagnosis of obstructive sleep apnea and neck circumference significant at the .01 level. There was no correlation between body mass index with a diagnosis of obstructive sleep apnea. Systolic hypertension showed a moderate inverse relationship of .28. This was an unexpected finding and concurrent treatment for hypertension may have been a confounding factor. 62% (n = 56) of the drivers reported receiving prescriptions for one or more medications which may have controlled the systolic, diastolic or both blood pressures when presenting for the medical examination.

Body mass index was not a good indicator for a diagnosis of obstructive sleep apnea according to this study. This may be due to the small sample size or possible restriction of range for this variable. This also may be due to people carrying their excess weight in different areas, often described as the apple or pear shaped figure. The Body mass index is a calculation of height and weight, but it does not account for people's weight distribution and those who carry more muscle weight and others who carry more fat weight. Neck circumference is definitely the more consistent predictive measure. Adding the neck circumference to the Department of Transportation medical examination does have value and needs implementation along with objective measures already collected such as height, weight, and blood pressure to detect drivers with under recognized and undiagnosed obstructive sleep apnea. This study supports the addition of neck circumference as part of the Department of Transportation medical exam process to identify drivers at high risk for obstructive sleep apnea.

Application to Practice

The goal of this project is to apply and sustain a change in practice applicable to all drivers presenting to the occupational medicine clinic. The knowledge gained from the

retrospective EMR review will help support the practice change and utilization by all Occupational Medicine providers.

Dissemination of the project information and findings will be available through the Occupational Medicine website and monthly newsletter for employers and employees to utilize as a resource. Presentations will be given at the local and state Nurse Practitioner meetings, National Conferences and the National Occupational Medicine conference. On presentation attention will be given to the lack of current guidance at the Federal level to support expedited change in practice for clinicians to utilize.

DNP Essentials

The Doctor of Nursing Practice (DNP) education allows nurses to develop into clinical experts and leaders in nursing practice. The eight essentials are defined by the American Association of Colleges of Nursing in 2006 (AACN, 2006). The essentials incorporate advanced education and training in the areas of science, organizational systems, clinical scholarship, informatics, health care policy, interprofessional collaboration to improve patient and population health, clinical prevention and advanced nursing practice (AACN, 2006) (see Table 1). This project meets the criteria for the 8 essentials of Doctoral Education for Advanced Nursing Practice as defined by the American Association of Colleges of Nursing (Appendix E).

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Appendix A

Epworth Sleepiness Scale

Use the following scale to choose the most appropriate number for each situation:

0 = *Never* doze or sleep
1 = *Slight* chance of dozing or sleeping
2 = Moderate chance of dozing or sleeping
3 = *High* chance of dozing or sleeping

Situation	**Chance of dozing or sleeping**
Sitting and reading	_____
Watching TV	_____
Sitting inactive in a public place	_____
Being a passenger in a motor vehicle for an hour or more	_____
Lying down in the afternoon	_____
Sitting and talking to someone	_____
Sitting quietly after lunch (no alcohol)	_____
Stopped for a few minutes in traffic while driving	_____
Total score	_____

Appendix B

DOT Sleepiness Risk Assessment

Name of Driver: _____ **Date of Exam:**_____ -_____ -_____

Screening Recommendation for Commercial Drivers with Possible or Probable Sleep Apnea

BMI: _____ kg/m ^{2} (action limit ≥35 kg/m^2)

Neck circumference: Male _____ inches (action limit >17 inches)
Female _____ inches (action limit >16 inches)

Hypertension: ❑ No ❑ Yes Medical Assistant initials:_____

❑ Medically qualified to drive commercial vehicles if driver meets either of the following:

1. No positive findings or any of the numbered in-service evaluation factors
2. Diagnosis of OSA with CPAP compliance documented

❑ In-Service Evaluation (ISE) recommended if driver falls into any one of the following major categories

1. Sleep history suggestive of OSA (snoring, excessive daytime sleepiness, witnessed apneas)
2. Two or more of the following:
   a. BMI ≥35 kg/m^2
   b. Neck circumference
      i. Males >17 inches
      ii. Females >16 inches
   c. Hypertension (new, uncontrolled, or unable to control with <2 medications)
3. ESS >10
4. Previously diagnosed sleep disorder; compliance claimed, but no recent medical visits/compliance data available for immediate review (must be reviewed within three month period); if found not to be compliant, should be removed from service (includes surgical treatment)
5. AHI >5 but <30 in a prior sleep study or polysomnogram and no excessive daytime somnolence (ESS <11), no motor vehicle accidents, no hypertension requiring two or more agents to control

❑ Out-of-service immediate evaluation recommended if driver meets any one of the following factors

1. Observed unexplained excessive daytime sleepiness (sleeping in examination or waiting room) or confessed excessive sleepiness
2. Motor vehicle accident (run off road, at-fault, rear-end collision) likely related to sleep disturbance, unless evaluated for sleep disorder in the interim
3. ESS ≥16 or FOSQ <18
4. Previously diagnosed sleep disorder:
   a. Noncompliant (CPAP treatment not tolerated)
   b. No recent follow up (within recommended time frame);
   c. Any surgical approach with no objective follow up
5. AHI >30

AHI indicates apnea-hypopnea index; BMI, body mass index; CPAP, continuous positive airway pressure; ESS, Epworth Sleepiness Scale; FOSQ, Functional Outcomes of Sleep questionnaire; OSA, obstructive sleep apnea.

Appendix C

Logic Model

Inputs	Activities	Outputs	Short Term Outcomes	Mid-Term Outcomes	Long-Term Outcomes
Stake holder CMVD Medical examiner Employer (Client Company) Research	Identify Stake holders Request approval from research site Request IRB permission Apply JTF criteria Measure neck Calculate BMI Measure blood pressure Record gender Complete medical forms (driver) Refer PSG	Complete retrospective chart review Compare self-reports of sleepiness to objectively measured sleep Analyze data PSG performed	Clinical screening tool applied Identification of at risk CMVD	Driver referred Objectively tested Identify drivers with AHI > 20 Increase driver knowledge	Develop a continuous high quality screening program Develop Educational program Improved health of driver

Appendix D

Medical Examination Report
FOR COMMERCIAL DRIVER FITNESS DETERMINATION

649-F (6045)

1. DRIVER'S INFORMATION Driver completes this section

Driver's Name (Last, First, Middle)	Social Security No.	Birthdate M / D / Y	Age	Sex ☐ M ☐ F	New Certification ☐ Recertification ☐ Follow-up ☐	Date of Exam
Address	City, State, Zip Code	Work Tel: ( ) Home Tel: ( )	Driver License No.	License Class ☐ A ☐ B ☐ C ☐ D ☐ Other		State of Issue

2. HEALTH HISTORY Driver completes this section, but medical examiner is encouraged to discuss with driver.

Yes	No	
☐	☐	Any illness or injury in the last 5 years?
☐	☐	Head/Brain injuries, disorders or illnesses
☐	☐	Seizures, epilepsy ☐ medication_
☐	☐	Eye disorders or impaired vision (except corrective lenses)
☐	☐	Ear disorders, loss of hearing or balance
☐	☐	Heart disease or heart attack; other cardiovascular condition ☐ medication_
☐	☐	Heart surgery (valve replacement/bypass, angioplasty, pacemaker)
☐	☐	High blood pressure ☐ medication_
☐	☐	Muscular disease
☐	☐	Shortness of breath

Yes	No	
☐	☐	Lung disease, emphysema, asthma, chronic bronchitis
☐	☐	Kidney disease, dialysis
☐	☐	Liver disease
☐	☐	Digestive problems
☐	☐	Diabetes or elevated blood sugar controlled by: ☐ diet ☐ pills ☐ insulin
☐	☐	Nervous or psychiatric disorders, e.g., severe depression medication_
☐	☐	Loss of, or altered consciousness

Yes	No	
☐	☐	Fainting, dizziness
☐	☐	Sleep disorders, pauses in breathing while asleep, daytime sleepiness, loud snoring
☐	☐	Stroke or paralysis
☐	☐	Missing or impaired hand, arm, foot, leg, finger, toe
☐	☐	Spinal injury or disease
☐	☐	Chronic low back pain
☐	☐	Regular, frequent alcohol use
☐	☐	Narcotic or habit forming drug use

For any YES answer, indicate onset date, diagnosis, treating physician's name and address, and any current limitation. List all medications (including over-the-counter medications) used regularly or recently.

_____

_____

_____

I certify that the above information is complete and true. I understand that inaccurate, false or missing information may invalidate the examination and my Medical Examiner's Certificate.

Driver's Signature Date_

Medical Examiner's Comments on Health History (The medical examiner must review and discuss with the driver any "yes" answers and potential hazards of medications, including over-the-counter medications, while driving. This discussion must be documented below.)

_____

_____

_____

_____

TESTING (Medical Examiner completes Section 3 through 7) Name: Last, First, Middle,

3. VISION

Standard: At least 20/40 acuity (Snellen) in each eye with or without correction. At least 70 degrees peripheral in horizontal meridian measured in each eye. The use of corrective lenses should be noted on the Medical Examiner's Certificate.

INSTRUCTIONS: When other than the Snellen chart is used, give test results in Snellen-comparable values. In recording distance vision, use 20 feet as normal. Report visual acuity as a ratio with 20 as numerator and the smallest type read at 20 feet as denominator. If the applicant wears corrective lenses, these should be worn while visual acuity is being tested. If the driver habitually wears contact lenses, or intends to do so while driving, sufficient evidence of good tolerance and adaptation to their use must be obvious. ***Monocular drivers are not qualified.***

Numerical readings must be provided.

ACUITY	UNCORRECTED	CORRECTED	HORIZONTAL FIELD OF VISION
Right Eye	20/	20/	Right Eye ◇
Left Eye	20/	20/	Left Eye ◇
Both Eyes	20/	20/	

Applicant can recognize and distinguish among traffic control signals and devices showing standard red, green, and amber colors ? ☐ Yes ☐ No

Applicant meets visual acuity requirement only when wearing:
☐ Corrective Lenses

Monocular Vision: ☐ Yes ☐ No

Complete next line only if vision testing is done by an opthalmologist or optometrist

Date of Examination | Name of Ophthalmologist or Optometrist (print) | Tel. No. | License No./ State of Issue | Signature

4. HEARING

Standard: a) Must first perceive forced whispered voice ≥ 5 ft., with or without hearing aid, or b) average hearing loss in better ear ≤ 40 dB
☐ Check if hearing aid used for tests. ☐ Check if hearing aid required to meet standard.

INSTRUCTIONS: To convert audiometric test results from ISO to ANSI, -14 dB from ISO for 500Hz, -10dB for 1,000 Hz, -8.5 dB for 2000 Hz. To average, add the readings for 3 frequencies tested and divide by 3.

Numerical readings must be recorded.

a) Record distance from individual at which forced whispered voice can first be heard.	Right ear \ Feet	Left Ear \ Feet

b) If audiometer is used, record hearing loss in decibels, (acc. to ANSI Z24.5-1951)	Right Ear 500 Hz	1000 Hz	2000 Hz	Left Ear 500 Hz	1000 Hz	2000 Hz
	Average:			Average:		

5. BLOOD PRESSURE/ PULSE RATE

Numerical readings must be recorded. Medical Examiner should take at least two readings to confirm BP.

Blood Pressure	Systolic	Diastolic

Driver qualified if ≤140/90.

Pulse Rate: ☐ Regular ☐ Irregular

Record Pulse Rate: _

Reading	Category	Expiration Date	Recertification
140-159/90-99	Stage 1	1 year	1 year if ≤140/90. One-time certificate for 3 months if 141-159/91-99.
160-179/100-109	Stage 2	One-time certificate for 3 months.	1 year from date of exam if ≤140/90
≥180/110	Stage 3	6 months from date of exam if ≤140/90	6 months if ≤ 140/90

6. LABORATORY AND OTHER TEST FINDINGS

Numerical readings must be recorded.

URINE SPECIMEN	SP. GR.	PROTEIN	BLOOD	SUGAR

Urinalysis is required. Protein, blood or sugar in the urine may be an indication for further testing to rule out any underlying medical problem.
Other Testing (Describe and record) _

7. PHYSICAL EXAMINATION

Height: (in.) Weight: (lbs.) Name: Last, First, Middle,

The presence of a certain condition may not necessarily disqualify a driver, particularly if the condition is controlled adequately, is not likely to worsen or is readily amenable to treatment. Even if a condition does not disqualify a driver, the medical examiner may consider deferring the driver temporarily. Also, the driver should be advised to take the necessary steps to correct the condition as soon as possible particularly if the condition, if neglected, could result in more serious illness that might affect driving.

Check YES if there are any abnormalities. Check NO if the body system is normal. Discuss any YES answers in detail in the space below, and indicate whether it would affect the driver's ability to operate a commercial motor vehicle safely. Enter applicable item number before each comment. If organic disease is present, note that it has been compensated for. See *Instructions to the Medical Examiner* for guidance.

BODY SYSTEM	CHECK FOR:	YES*	NO
1. General Appearance	Marked overweight, tremor, signs of alcoholism, problem drinking, or drug abuse.		
2. Eyes	Pupillary equality, reaction to light, accommodation, ocular motility, ocular muscle imbalance, extraocular movement, nystagmus, exophthalmos. Ask about retinopathy, cataracts, aphakia, glaucoma, macular degeneration and refer to a specialist if appropriate.		
3. Ears	Scarring of tympanic membrane, occlusion of external canal, perforated eardrums.		
4. Mouth and Throat	Irremediable deformities likely to interfere with breathing or swallowing.		
5. Heart	Murmurs, extra sounds, enlarged heart, pacemaker, implantable defibrillator.		
6. Lungs and chest, not including breast examination	Abnormal chest wall expansion, abnormal respiratory rate, abnormal breath sounds including wheezes or alveolar rales, impaired respiratory function, cyanosis. Abnormal findings on physical exam may require further testing such as pulmonary tests and/or xray of chest.		
7. Abdomen and Viscera	Enlarged liver, enlarged spleen, masses, bruits, hernia, significant abdominal wall muscle weakness.		
8. Vascular System	Abnormal pulse and amplitude, cartoid or arterial bruits, varicose veins.		
9. Genito-urinary System	Hernias.		
10. Extremities- Limb impaired. Driver may be subject to SPE certificate if otherwise qualified.	Loss or impairment of leg, foot, toe, arm, hand, finger, Perceptible limp, deformities, atrophy, weakness, paralysis, clubbing, edema, hypotonia. Insufficicent grasp and prehension in upper limb to maintain steeringwheel grip. Insufficient mobility and strength in lower limb to operate pedals properly.		
11. Spine, other musculoskeletal	Previous surgery, deformities, limitation of motion, tenderness.		
12. Neurological	Impaired equilibrium, coordination or speech pattern; asymmetric deep tendon reflexes, sensory or positional abnormalities, abnormal patellar and Babinki's reflexes, ataxia.		

*COMMENTS: _____

Note certification status here. See Instructions to the Medical Examiner for guidance.

- ☐ Meets standards in 49 CFR 391.41; qualifies for 2 year certificate
- ☐ Does not meet standards
- ☐ Meets standards, but periodic monitoring required due to
  Driver qualified only for: ☐3 months ☐6 months ☐1 year ☐ Other
- ☐ Wearing corrective lense
- ☐ Wearing hearing aid
- ☐ Accompanied by a waiver/exemption. Driver must present exemption at time of certification.
- ☐ Skill Performance Evaluation (SPE) Certificate
- ☐ Driving within an exempt intracity zone (See 49 CFR 391.62)
- ☐ Qualified by operation of 49 CFR 391.64

Temporarily disqualified due to (condition or medication):

Return to medical examiner's office for follow up on

Medical Examiner's signature

Medical Examiner's name

Address

Telephone Number

If meets standards, complete a Medical Examiner's Certificate as stated in 49 CFR 391.43(h). (Driver must carry certificate when operating a commercial vehicle.)

Appendix E

The Essentials of Doctoral Education for Advanced Nursing Practice

Evidence of Completion

DNP Essentials	Evidence from DNP Project
Scientific Underpinnings for Practice	Integrated nursing science and Rosswurm & Larrabee's (1999) theory of change to support a clinical practice change, screening the CMVD for unrecognized OSA, a significant public health issue.
Organizational and Systems Leadership for Quality Improvement and Systems Thinking	Conducted organization and medical provider meetings to determine interest and gain support for the DNP investigation and quality improvement project.
Clinical Scholarship and Analytical Methods for Evidence-Based Practice	Analytical review of literature and research studies.
Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care	Demonstrated technical skills to develop and execute an analysis involving data extraction from practice information and database.
Health Care Policy for Advocacy in Health Care	Engaged in the development and implementation of health care policy at the institutional level. This has helped to alleviate the fragmentation of healthcare and systems failure with lack of screening and recognition of OSA by the primary care provider.
Interprofessional Collaboration for Improving Patient and Population Health Outcomes	Collaborated with organizational leadership, physicians, clinic staff and specialty sleep centers to advance the health of the CMVD to create change in healthcare delivery. Facilitated interprofessional communication and educated about the role of the DNP.
Clinical Prevention and Population Health for Improving the Nation's Health	The project supports Healthy People 2020 to reduce the rate of vehicular crashes due to drowsy driving and the National Healthy Sleep Awareness project.
Advanced Nursing Practice	Demonstrated advanced clinical judgment and systems thinking, evidenced by designing and implementing evidence-based care to improve patient outcomes. Integrated conceptual and analytical skills evaluating the links among practice, organizational ,population and policy issues.