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Efficiency Of Ambulatory Blood Pressure Monitoring Vs. 5-Day Serial Monitoring In A Military Treatment Facility

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EFFICIENCY OF AMBULATORY BLOOD PRESSURE MONITORING VS. 5-DAY
SERIAL MONITORING IN A MILITARY TREATMENT FACILITY

by

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Dedication

I dedicate this DNP Project to all the Soldiers, Airmen, Coast Guardsmen, Sailors and Marines for their selfless service to our great nation. To all of my friends and family for their unwavering support and most importantly to my L7 hero and husband Paul LeRoy, I love you!

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Abstract

The purpose of this process improvement project is to determine efficiency of ambulatory blood pressure monitoring (ABPM) vs. 5-day blood pressure checks in a military treatment facility. The sample consists of male and female active duty soldiers ages 18 to 54 years without a previous diagnosis of hypertension (HTN). The soldiers were assigned to a unit that is physically and mentally challenging, has demanding training opportunities and duty requirements, and are rapidly deployable in support of peacekeeping, humanitarian and combat missions.

The data collection method included a retrospective chart review of 128 charts randomly selected between June 2016 and May 2017. The 128 charts had an ICD-10 code of elevated blood pressure without a diagnosis of hypertension. Sixty-five charts utilized ABPM and sixty-three charts used 5-day blood pressure checks. Efficiency for both methods of blood pressure monitoring was measured in calendar days to determine number of days for a soldier to: a) see a provider with a suspicion of HTN and initiate prescribed method of blood pressure monitoring, b) complete the prescribed method of blood pressure monitoring, and c) follow up with a provider for determination

Findings were documented on the Client Data and Data Points tool and analyzed using SAS 9.4. A significant difference was found between ABPM and 5-day blood pressure checks for the number of days it took for the soldier to initiate the prescribed method by a mean 5.46 (SD2.11) and 14.87 (SD 8.43), the time it took the soldier to complete the

prescribed method with a mean 6.73 (SD 3.04) and 10.97 (SD7.05) and determination of a diagnosis with a mean 12.22 (SD3.67) and 25.84 (SD 11.70) respectively. Analysis of the data using t-tests determined that use of ABPM was statistically significant when compared to 5-day blood pressure checks (p=<.0001). Although the benefits in use of ABPM has been studied and recommended for practice, implementation of use in the primary care setting has not been fully applied. Based on results, recommendations for this process improvement project are to implement ABPM into clinical practice to improve patient outcomes.

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List of Abbreviations

ABPM ....Ambulatory Blood Pressure Monitor

ADSM... Active Duty Service Member

AHA... American Heart Association

APRN ....Advanced Practice Registered Nurse

BMI .... Body Mass Index

CDC .... Centers for Disease Control and Prevention

CPG .... Clinical Practice Guideline

DoD .... Department of Defense

DNP.. Doctorate in Nursing Practice

EMR .... Electronic Medical Record

MTF ....Military Treatment Facility

NICE .... National Institute of Clinical Excellence

PCM ....Primary Care Manager

PTSD ....Post Traumatic Stress Disorder

SOP .... Standard Operating Procedure

USPSTF ....US Preventive Services Task Force

VA .... Veterans Affairs

WHO ....World Health Organization

Chapter 1

Introduction

According to the Centers for Disease Control and Prevention (CDC, 2016), hypertension was the primary contributing factor in the cause of death for more than 410,000 Americans in 2014. Pickering et al. (2005), stated that elevated blood pressure was the largest contributing risk factor to all-cause and cardiovascular mortality. Known as an asymptomatic but deadly disease, hypertension is common in both the general and military population and the prevalence continues to increase. The World Health Organization (WHO, 2015) predicted that elevated blood pressure will be the leading cause of death by the year 2020 in the world. An early diagnosis can be the key to life saving treatment with lifestyle modifications or medication therapy.

Hypertension is common in older populations with a prevalence of 65% in those 60 years of age or older compared to the young with a prevalence of 8% in those 18-39 years of age. Compared with the general United States (US) population, the US Armed Forces is a young population with 92% of service members being under the age of 40 (Smoley, Smith, & Guy, 2008). Army soldiers are vetted prior to entering on active duty to ensure health, fitness and medical readiness in preparation for deployment for humanitarian, peacekeeping and combat missions. A hypertension diagnosis is considered a medical disqualification to enter on active duty and is a cause for separation from the services (Army Regulation 40-501, Department of the Army, 2017). In

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2016, essential hypertension accounted for 52,586 encounters for health care among 29,612 Active Duty Service Members (ADSM) in the U.S. Armed Forces (Armed Forces Health Surveillance Branch, 2017). Of all cardiovascular diseases, essential hypertension is by far the most common specific condition diagnosed among ADSMs (Armed Forces Health Surveillance Branch, 2017). Risk factors for development of hypertension include modifiable and non-modifiable categories. Non-modifiable risks include age, gender, race/ethnicity, family history and genetics. Modifiable risk factors include diet, physical inactivity, obesity, high stress, alcohol consumption, tobacco, and stimulant use.

Soldiers are responsible for meeting physical fitness and weight control program standards prescribed in the Army Regulation 600-9 (Army Regulation 600-9, Department of the Army, 2013). Army Regulation 600-63 (2014), emphasizes physical fitness, nutrition, stress management, appropriate supplement use and decrease use of tobacco and alcohol consumption. Illicit drug use is lower among ADSMs than the general US population, but heavy alcohol consumption and tobacco use are more prevalent. Stresses of deployment during wartime and the unique culture of the military account for some of these differences. Supplement use to include caffeine and stimulants are high among ADSMs. Energy drinks are a beverage of choice for many ADSMs. The Walter Reed Army Institute of Research analyzed data collected in 2010 and found nearly 45 percent of ADSMs consumed at least one energy drink daily and nearly 14 percent reported drinking three or more per day. Many of the young soldiers mix energy drinks with alcohol beverages. Overall tobacco use in the general and military populations has decreased, but the prevalence of use is still higher among people currently serving in the military with a prevalence of 24% ADSMs using tobacco compared to 19% civilians

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(Barlas, Higgins, Pflieger & Diecker, 2011). Smokeless tobacco use is 12.8% among ADSMs compared to 3.2% in the general population. Alcohol use is also higher among ADSMs than their civilian counterparts.

Alcohol use to include binge drinking is significantly higher in ADSMs compared to civilians. Service members aged 18 to 25 had an alcohol use rate of 25% compared to civilians in the same age group at 16%. Across all age groups, ADSMs had an alcohol use rate of 20 percent compared to civilians at 14 percent (Barlas, Higgins, Pflieger & Diecker, 2011).

The population of interest in this Doctorate in Nursing Practice (DNP) project has physically and mentally demanding training opportunities and duty requirements that limit a soldier's desire to seek care. Elevated blood pressure measurements are incidental findings and based on the current method of diagnosing hypertension at this Military Treatment Facility (MTF), 5-day blood pressure measurements; perceived loss of time away from training and missions is viewed as detrimental. The ability to more efficiently assess for a hypertension diagnosis using ambulatory blood pressure monitoring (ABPM) has the potential to increase medical readiness and improve clinical outcomes.

Confirming a diagnosis of hypertension can be done through various methods. This DNP process improvement project will compare efficiency of the 5-day blood pressure checks versus the 24-hour ABPM as methods for diagnosing hypertension in this military population. Five-day blood pressure checks is the current method used to diagnosis hypertension at the clinic were the project will take place. If the patient is able to complete this method in five consecutive days, it can take up to seven primary care visits before a patient is diagnosed. Five-day blood pressure checks can be time

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consuming, delay diagnosis and treatment and use increased primary care resources already strained by multiple factors. The US Preventive Services Task Force (USPSTF, 2015) states 24-hour ABPM is the recommended method for confirming a hypertension diagnosis.

Ambulatory blood pressure monitoring takes approximately three primary care visits and has the potential to provide a more efficient means of diagnosing hypertension (USPSTF, 2015). Through use of preapproved retrospective data accessed via the Department of Defense (DoD) Electronic Medical Records (EMR), this DNP project will examine if the use of 24-hour ABPM is more efficient than use of 5-day blood pressure checks in determining a diagnosis of hypertension in ADSM.

Description of the Clinical Problem

Approximately 75 million American adults have hypertension and half of these adults, 35 million, do not have their hypertension under control (Nwankwo, Yoon, Burt & Gu, 2013). According to the CDC (2016) roughly 33% of adults with high blood pressure are unaware they have hypertension. Research shows that frequent screening for high blood pressure is imperative and yields strong benefits in substantially reducing the incidence of cardiovascular events (USPSTF, 2015). The minimum frequency of screening recommended by USPSTF (2015) should be as follows:

- Adults 40 years or older should have their blood pressure measured at least annually.

- Adults between 18 and 39 years should be screened at least annually if they have risk factors for hypertension (eg, unhealthy diet, physical inactivity, obesity, alcohol and/or tobacco use, family history, or other

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medical conditions such as diabetes or high cholesterol) or if their previously measured blood pressure was 130-139/85-89 mmHg.

- Adults between 18 and 39 years whose latest blood pressure was <130/80 mmHg and have no risk factors for hypertension should be screened at least every three years.

For ADSM's, increased blood pressure screening frequency may be necessary due to multiple factors such as Post Traumatic Stress Disorder (PTSD) and other stressors unique to military service members. Hypertension is a common condition, but little is known about its prevalence in the Armed Forces (Smoley, Smith, & Guy, 2008). A 2014 study by the DoD, determined that in 2008, 13% of ADSMs had hypertension, the majority of which were under the age of 40. Hypertension can be caused by unknown or known causes. Unknown causes of hypertension are classified as primary or essential hypertension. Ninety-five percent of hypertension cases are classified as primary hypertension and usually develops gradually over many years. High risk factors include advanced age, obesity, family history, race, high-sodium diet, excessive alcohol consumption, tobacco use and physical inactivity (Basile & Bloch, 2016). According to the WHO (2013) some of these behavioral risk factors are highly influenced by people's working and living conditions. Soldier's lifestyles place them at a higher risk for hypertension due to stress.

Stress is postulated to increase blood pressure through the release of corticoids and inhibition of prostaglandin synthesis, which regulates blood pressure (Granado et al, 2009). Military careers are high stress, and many Soldiers cope with this stress by smoking, drinking and eating unhealthy diets. Military deployment may present profound

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psychological and physical stressors to deployers, such as exposure to life-threatening

situations, exposure to deceased or maimed bodies, and suboptimal living conditions

(Granado et al., 2009). The American Heart Association (AHA) also reports that combat

exposure may exert long-term adverse effects on cardiovascular health (Eckel, Jakicic,

Ard et al., 2014). These factors combined may result in a high proportion of Soldiers

suffering from hypertension.

Currently, the Veterans Affairs/Department of Defense (VA/DoD) Clinical

Practice Guidelines CPG (2014) recommends establishing a diagnosis of hypertension

based on at least two blood pressure readings on two separate patient visits. Standard

operating procedures (SOPs) followed at the location of this DNP project, recommends

the use of 5-day blood pressure checks to assist in the diagnosis of hypertension. Based

on this established protocol, healthcare providers (Physicians, Physician's Assistants and

Family Nurse Practitioners) who suspect a soldier has hypertension use the 5-day blood

pressure checks method to determine a diagnosis of hypertension. A blood pressure

measurement of 140/90 mmHg or greater should clue a healthcare provider to the

suspicion of hypertension (Daskalopoulou et al., 2015).

Five-day blood pressure measurements in the clinical setting over a short period

of time has been the standard method of diagnosing hypertension. The National Institute

for Health and Clinical Excellence (NICE) believes this practice may have led to over

diagnosis and over treatment of hypertension in some individuals (2011). Five-day blood

pressure checks have several disadvantages; a single clinic blood pressure measurement

may not accurately reflect levels in the out-of-clinic naturalistic setting (Shimbo, Abdalla,

Falzon, Townsend & Munter, 2015), white-coat and masked hypertension phenomena,

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poor reproducibility of office measurements and observer issues such as prejudice and bias (Boubouchairopoulou et al., 2014). Ambulatory blood pressure measurements capture multiple measurements over a 24-hour period of the individual's day, requires one trained technician to fit the individual with the monitor device and enables the measuring of nighttime blood pressures and diurnal changes, which may be the most accurate predictors of risk associated with elevated blood pressure (Drawz, Abdalla, & Rahman, 2012).

Scope of the Problem

Blood pressures measured under routine conditions may be significantly higher than readings taken following recommended guidelines (Drawz, Abdella, & Rahman, 2012). It is well documented that blood pressure can increase substantially in the medical setting and in the presence of medical personnel, otherwise known as white coat syndrome (Piper et al., 2014). Epidemiological data suggest that 15-30% of the population thought to have hypertension may have lower blood pressure outside of the medial setting (Piper et al., 2014). Over-diagnosis of hypertension causes an increase in medication prescribing, diagnostic work up to include screening labs, and cost to society (CDC, 2016).

Office measurements are confined to a short period of the diurnal cycle and are not indicative of blood pressure behavior throughout the day (Edwards & Simpson, 2014). Multiple measurements in determining a diagnosis of hypertension is limited by the number of measurements that can be performed conveniently, high rate of observer error, and potentially altering effects of the medical setting and medical personnel (Piper

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et al., 2015). Repeating office blood pressure measurement at a separate office visit to confirm hypertension is subject to the same limitations as above.

The significance of this project is to highlight a recommended method, ABPM, for measuring blood pressure in the diagnosis of hypertension. The project will examine the most efficient method to measure blood pressure.

Analysis of Current Practice

The gold standard for clinical blood pressure measurement has always been readings taken by a trained health care professional using a mercury sphygmomanometer and the Korotkoff sound technique (Pickering et al., 2005). Due to environmental concerns, mercury sphygmomanometers have been phased out. Use of digital oscillometric upper arm devices have been widely adopted for use in obtaining blood pressure measurements in primary care clinics. These devices consist of an aneroid sphygmomanometer with an inflatable cuff, a measuring unit and a mechanism for inflation that is typically a pump operated electronically. Aneroid manometers, that use a lever and bellows system as opposed to a mercury column, are less accurate and often need frequent calibration (Ogedegbe & Pickering, 2010).

The American Heart Association (Pickering et al., 2005) established recommendations in obtaining clinic blood pressure readings. Recommendations include blood pressure be measured after a patient sits comfortably and quietly for at least 5 minutes in a chair with back supported, both feet flat on the floor, and the unbent arm supported at heart level at mid-sternum. The appropriate cuff size should be used on a bare arm; not over clothing, and the inflatable bladder should encircle 80 percent or more of the patient's arm circumference. Additionally, extraneous factors that influence blood

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pressure such as smoking, and caffeine intake should be minimized. When this method is properly performed using standardized criteria it can predict target organ damage, and correlates well with ambulatory measurements (Daskalopoulou et al., 2015). However, other studies have shown that in routine clinical practice standardized office blood pressure measurement is not commonly performed and it has been shown that educational programs to improve the quality of manual office blood pressure measurement have not been successful (Daskalopoulou et al., 2015).

Assessment of blood pressure, along with pulse, respirations, temperature, peripheral capillary oxygen saturation (SpO2), and height and weight, is performed at all acute, routine, and preventive care visits of soldiers in the primary care clinics for this project setting. When a soldier is suspected of having hypertension through an elevated blood pressure reading, the healthcare provider provides the soldier with a 5-day blood pressure form (Appendix A). The soldier is instructed to return to the clinic at the same time every day for five consecutive days to obtain blood pressure measurements. Soldiers are encouraged to continue with physical activity, but are instructed to refrain from tobacco, caffeine and other stimulant use approximately one hour prior to obtaining measurement.

Five-day blood pressure checks significantly impact time and resources for both the soldier and clinic staff. In a clinic setting it takes a minimum of 14 minutes to obtain a blood pressure reading using the previously stated AHA guidelines for obtaining blood pressure measurement. The process using the 5-day procedure entails the soldier taking time away from work and duty completion. Based on duties and responsibilities, five consecutive days is not always a feasible option and can take well over five days to

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achieve. Furthermore, it may not be reasonable to expect a soldier to refrain from tobacco, caffeine or other stimulant use for consecutive days for an accurate reading to be maintained.

Current reliance on clinic blood pressure alone has likely resulted in substantial over diagnosis of hypertension; ambulatory monitoring might allow for more appropriate targeting of patients most likely to benefit from lifelong drug treatment (Drawz, Abdalla, & Rahman, 2012). This process improvement project will examine when diagnosing 18 to 54 year old Active Duty soldiers with hypertension, how does implementation of 24-hour ambulatory blood pressure monitoring compare to the current protocol of 5-day blood pressure checks in improving the efficiency of a hypertension diagnosis and time to follow up visit?

Best Practice to Address Problem

High blood pressure is the most important modifiable risk factor for the leading cause of death in North America, Coronary Heart Disease, the third leading cause of death in North America, Stroke and Congestive Heart Failure, end-stage renal disease, and peripheral vascular disease (Haws, 2015). Blood Pressure exhibits a diurnal pattern, whereby pressure is generally the lowest during sleep, rises sharply and peaks after a person rises from bed, and then falls again during the day (Piper et al., 2015).

Nighttime blood pressure is a stronger predictor of mortality and cardiovascular events than daytime blood pressure and this data can be captured with use of ABPM. Twenty-four-hour ABPM gives a better prediction of risk than office measurements (Pickering et al., 2005). Nocturnal blood pressure is the best prognostic indicator of cardiovascular outcome (de la Sierra et al., 2011). Ambulatory blood pressure

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measurement better correlates with cardiovascular outcome (Lovibold et al., 2011) and is the only measurement method that is able to capture nocturnal blood pressure readings. Feasibility and cost-effectiveness have been demonstrated using ABPM, along with its ability to provide information that can improve management and blood pressure control (O'Brien et al., 2011).

At the project location, ABPM requires a referral from a healthcare provider to the Cardiology Procedures section within the Cardiology Department. Within 72 hours of referral submission, the soldier receives a telephonic call from Cardiology Procedures and is scheduled for a device fitting. Per discussion with the chief Cardiology Procedure technician, the soldier on average receives a call within 24 hours of the referral being placed. The technician fits the soldier for the device per Cardiology protocol detailed in Appendix B. The soldier wears the device for a full 24-hour period. At the end of the 24-hour period, the Soldier returns the device to Cardiology Procedures, per appointment scheduled immediately after fitting, for data download and interpretation by a Cardiologist. The referring healthcare provider receives a notification via the EMR advising of the soldiers ABPM results within 48 hours of monitor turn in.

Ambulatory blood pressure monitoring measures blood pressure at regular intervals over a 24-hour period while patients continue with normal daily activities, including sleep. A properly trained technician fits the patient, with a device that should be validated according to the protocols established by the European Society of Hypertension and the American Association for Medical Instrumentation (Drawz, Abdalla, & Rahman, 2012). The patient is given detailed instructions to ensure the monitor stays attached, to continue to conduct their normal daily activities, and to keep the monitored arm steady

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and level with the heart during each reading for the entire 24-hour period as detailed in Appendix B. The probability that a soldier will follow prescribed directions is likely since the soldier will need to be cleared and be medically ready to return to their duties. Furthermore, patients are instructed to maintain a diary of sleep and wake times to be given to the Cardiology technician for documentation.

The ABPM device records blood pressure measurements over a 24 to 48-hour period, usually every 15-20 minutes during the daytime and every 30 to 60 minutes during sleep (Kaplan, Thomas & Pohl, 2016). The recorded blood pressures are calculated from the data by a computer. The prescribing provider then receives a report with comprehensive and concise data for clinical use. Implementation of the 24-hour ABPM within current practice has the potential to provide a much faster time to diagnosis of hypertension, save patient and provider time, save costs due to lost work hours to patients, clinic resources, improve clinical outcomes and prevents initiation of medication in inappropriately diagnosed patients.

Statement of the Problem

It is not currently known whether the use of ABPM compared to use of 5-day blood pressure, can significantly decrease the time between suspicion of hypertension in a patient and a definitive diagnosis and time to follow up visit. This process improvement application oriented project will provide information to primary care providers within a MTF to use a more efficient and accurate means in diagnosing hypertension.

Project Questions

A Population, Intervention, Comparison, Outcome and Time (PICOT) format was used to formulate the question for this project. Formulating clinical questions in a

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structured, specific way, such as with PICO formatting, assists the clinician in finding the

right evidence to answer questions and decrease uncertainty (Melnyk, & Fineout-

Overholt, 2011). Using the PICOT formula allows clinicians to create well-built

questions.

PICOT Question:

When diagnosing 18 to 54 year old Active Duty soldiers with hypertension, how does

implementation of 24-hour ambulatory blood pressure monitoring compare to the current

protocol of 5-day blood pressure checks in improving the efficiency of a hypertension

diagnosis and time to follow up visit?

Beyond the PICOT question of efficiency, this project will potentially answer

other questions such as a) What are the number of office visits needed to adequately

diagnose; hypertension?; b) How do the two methods compare for diagnosis and

treatment of hypertension?; c) Will use of ABPM allow healthcare providers to initiate

timely drug treatment if necessary?

Table 1.1 PICOT Question

Population	Intervention	Comparison	Outcome	Time
Active Duty Service Members aged 18 to 54	24-Hour Ambulatory Blood Pressure Monitor	5-day Blood Pressure Checks	Compare (24-h ABPM vs 5-day B/P Check) for efficiency of diagnosis and treatment of hypertension as measured by: 1. Number of office visits from suspicion of HTN to PCM follow up for determination of diagnosis. 2. Individuals mean blood pressure for	June 2016 to May 2017

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			the intervention and comparison modality 3. Application of JNC7 Guidelines	

Definitions

Blood pressure is classified into four categories based on a systolic or diastolic measurement. See Table 1.2.

Table 1.2 Blood Pressure Classification

Classification	Systolic	Diastolic
Normal	<120	<80
Prehypertension	120-139	80-89
Stage 1	140-159	90-99
Stage 2	≥160	≥100

(Chobanian, Bakris, & Black, 2003)

Prehypertension is not a disease category, but a classification to signify an increased risk for progression to hypertension (VA/DoD, 2014). Hypertension is defined as a systolic measurement >140 mmHg, or a diastolic measurement of >90 mmHg (USPSTF, 2015). This definition applies to adults age 18 and older, on no antihypertensive medications and who are not acutely ill. Measurements for a diagnosis of hypertension are based on the average of >2 seated blood pressure measurements, properly measured with well-maintained equipment, at each of >2 visits to the office or clinic (Chobanian, Bakris, & Black, 2003). White coat hypertension, as defined by Basile and Bloch (2016), is blood pressure that is consistently elevated by office readings but does not meet diagnostic criteria for hypertension based upon out-of-office readings. For the purpose of this

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project, efficiency is defined as the time between suspected hypertension to follow up with healthcare provider to determine diagnosis of hypertension and initiate treatment between the two methods being compared.

Active Duty Service Member refers to a soldier, Sailor, Airmen or Marine who is on full time active duty for the Army, Navy, Air Force or Marines. In this instance, ADSM refers to Army soldiers. Soldier is defined as an ADSM age 18 years or older serving in the Army. Clinical practice guidelines (CPGs) are evidence-based recommendations established to help guide treatment and ensure best practices and resources are properly utilized. The Seventh Joint National Committee JNC7 (Chobanian, Bakris, & Black, 2003), Eighth Joint National Committee JNC8 (James et al., 2014), CHEP (Daskalopoulou et al., 2015; Logan et al., 2015), NICE (2011), AHA (Eckel, Jakicic, Ard et al., 2013) and VA/DoD (2014) CPGs were all established to help guide screening, diagnosis, treatment and management of hypertension. Referral is the process of sending a patient to a clinical specialty or agency for further assessment or treatment, in this case, fitting for ambulatory monitor device.

Oscillometric devices used in obtaining blood pressure measurements use an electronic pressure sensor with a numerical readout of blood pressure. A cuff is placed on the patient's upper arm, just above the brachial artery, and inflated to a pressure about 20 mmHg above the systolic arterial pressure. When the cuff is fully inflated to this pressure, no blood flow occurs through the artery. As the cuff is deflated below the systolic pressure, the reducing pressure exerted on the artery allows blood to flow through it and sets up a detectable vibration in the arterial wall. When the cuff pressure falls below the patient's diastolic pressure, blood flows smoothly through the artery in the usual pulses

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(Ogedegbe & Pickering, 2010). These numbers provide both a systolic and diastolic number equal to a blood pressure measurement. Military Treatment Facilities are hospitals and clinics located on military bases where service members and their beneficiaries receive health care. Durable medical equipment is defined by the Centers for Medicare and Medicaid Services (2017) as equipment furnished by a supplier or a home health agency that meets the following conditions; a) can withstand repeated use, b) has an expected life of at least 3 years, c) is primarily and customarily used to serve a medical purpose, d) generally is not useful to an individual in the absence of an illness or injury, e) is appropriate for use in the home.

Assumptions

One could assume that the scope of practice between military healthcare providers is different. However, the Advanced Practice Registered Nurse (APRN) is a licensed and privileged practitioner and, as such, co-signature by a physician or other privileged provider of APRN entries in the patient's medical record, prescriptions, and so forth, is not required (Army Regulation 40-68, U.S. Department of the Army, 2009). Assumptions were made in reference to this DNP project.

- all encounters included in the project are complete to include data captured in the EMR and appropriately documented by the healthcare provider

- all equipment used in both 5-day blood pressure measurement and ABPM methods were calibrated according to manufacture recommendations and/or Army Regulation for maintenance of medical equipment

- all blood pressure measurements obtained using the 5-day blood pressure method were performed according to the AHA recommendations

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Framework

The Iowa Model of Evidence-Based Practice to Promote Quality Care is the standard framework for this project. Established in 1994 this model approaches Evidence Based Practice (EBP) from an organizational perspective and allows us to focus on knowledge and problem-focused triggers, leading staff to question current nursing practices and whether care can be improved through the use of current research findings (Doody & Doody, 2011). The model consists of seven steps. Step one is selection of a topic. Efficiency in diagnosing hypertension in ADSMs is imperative to mission accomplishment. An unknown or suspected diagnosis of hypertension can render a soldier non-medically ready. Selection of this topic was based on a need to more efficiently determine a diagnosis of hypertension with the potential to improve medical readiness and improve clinical outcomes. Step two in the model is to determine if the question is relevant to organizational priorities. If the question posed is relevant; the next step in the model is to determine if there is any evidence to answer the question.

Step three, evidence retrieval, will be performed through electronic databases such as Cinahl, PubMed, and Cochrane. Other sources of evidence will be obtained through the National Guideline Clearinghouse, Agency for Healthcare Research and Quality and secondary review of references from key papers obtained from electronic database searches. If there is insufficient evidence, then the model supports that new evidence should be generated through research. Steps four and five include grading the evidence and if the change is appropriate, making recommendations for adoption into practice. If the process improvement DNP project is approved for adoption into clinical

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practice steps six and seven include implementing the evidence-based practice and evaluating.

Summary

Determining a diagnosis of hypertension in highly deployable ADSMs has the potential to improve medical readiness, duty completion and positive patient outcomes. Comparing two available and recommended methods, 5-day blood pressure measurements and ABPM, for efficiency is the purpose of this process improvement DNP project. The clinical problem and scope of the problem discussed above generated the project PICOT question. Analysis of current practice, best practice to address the problem, statement of the problem and the evidence-based framework, The Iowa model (Titler, 2001), has been discussed regarding the purpose of the project.

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Chapter 2

Literature Review

Ambulatory blood pressure monitoring is the most accurate way of diagnosing hypertension in adults (Haws, 2015). The purpose of this process improvement DNP project is to determine if use of ABPM is more efficient than 5-day blood pressure measurements in obtaining a diagnosis of hypertension. Chapter two describes the evidence search strategy, synthesis of the literature, and barriers and supports of adoption of ABPM into clinical practice.

Analysis of Evidence

A search of the current literature related to the screening, diagnosis, treatment and management of hypertension was performed to answer the PICOT question. PICOT is defined as "Patient population, Intervention or Issue of interest, Comparison intervention or group, Outcome, and Time frame (Melnyk & Fineout-Overholt, 2011). PICOT format questions provide a means of helping practitioners formulate the question in order to find the information they need and can be used for any type of evidence-based practice inquiry (Titler, 2001).

Articles used to answer the PICOT question of intervention were retrieved from searches performed in PubMed, Cochrane Library, CINAHL Plus with Full Text, and Essential Evidence Plus databases accessed through the project location intranet website. Clinical Practice Guidelines were obtained through the above search and from both the

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National Guideline Clearinghouse and Agency for Healthcare Research and Quality websites. Key search words included but were not limited to adults, military, hypertension, high blood pressure, ambulatory blood pressure monitoring, blood pressure check, and cardiovascular risk. Different combinations of these terms, controlled vocabulary, and MeSH terms were employed to narrow the search and increase yield of relevant evidence. Filters and limitations placed include articles within the last five years; ages 19 +, and subject type; humans. Due to the initial lack of articles retrieved, the timeframe was expanded to 15 years. Inclusion criteria encompassed settings and patient populations consistent with the PICOT question. Because not many articles existed on ADSMs or military primary care settings, search terms were expanded to adults, 18 years of age or older, and primary care. Studies reported exclusively in a language other than English were excluded. Additionally, a secondary review of references from key papers was performed to ensure completeness of the literature search. Table 2.1 details search strategies and results.

Table 2.1 Search Strategy and Results

Cinahl		
Search Terms	**Number of Articles Retrieved**	**Number of Articles Used**
Military, High BP	137	1
Armed Forces, High BP screening	193	5
ABPM, HTN diagnosis, CV Risk	8	1
BP determination, HTN diagnosis	350	6
PubMed		
Search Terms	**Number of Articles Retrieved**	**Number of Articles Used**
Military, BP screening, PC, CV Risk	498	2

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| ABPM, PC, Armed Forces | 246 | 2 |
| HTN diagnosis, PC, ABPM | 204 | 0 |

Evidence Essential Plus		
Search Terms	**Number of Articles Retrieved**	**Number of Articles Used**
BP screening, diagnosis	7	1
BP screening, PC, ABPM	0	0
Hypertension screening, diagnosis	375	0
BP determination, HTN	18	0

Cochrane		
Search Terms	**Number of Articles Retrieved**	**Number of Articles Used**
BP screening HTN, Military	34	1
BP screening, PC ABPM, HTN diagnosis	0	0
ABPM, PC, HTN diagnosis	282	2

KEY

ABPM- Ambulatory Blood Pressure Monitoring
BP- Blood Pressure
CV- Cardiovascular
PC- Primary Care
HTN- Hypertension

Synthesis of Literature

Citations of interest included 17 articles; one Randomized Controlled Trial

(RCT), 14 Systematic Reviews of the literature, two included meta-analysis of RCTs, one

comparative design, and one cohort study. Several articles from different database

searches were repeat articles and only used once. The evidence overwhelmingly supports

that use of ABPM be implemented as a means to confirm hypertension diagnosis prior to

the initiation of drug therapy due to being most accurate and cost-savings. Chobanian,

Bakris, & Black (2003) performed an evidence review demonstrating new data indicating

the need for reclassification of blood pressure. New terminology included the term

prehypertension defined as blood pressure ranging from 120 to 139 mmHg systolic

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and/or 80 to 89 mmHg diastolic. Through a systematic review of the literature, Lovibond et al. (2011) and Boubouchairopoulou et al. (2014) determined ABPM as the most effective strategy in costs for hypertension diagnosis when compared to clinic blood pressure measurements. In a comparative design by Lovibond et al. (2011) using a Markov model-based probabilistic cost-effective analysis in terms of lifetime costs (95% CI €56 (-105 to -10) in men aged 75 years and €323 (-389 to -222) in women aged 40 years) and quality-adjusted life years (men and women older than 50 years (from 0.006 for women aged 60 years to 0.002) and for men aged 70 years). Ambulatory blood pressure monitoring was cost-savings when compared to clinic and home blood pressure measurements. Boubouchairopoulou et al. (2014) determined the total cost in monitoring was lower in clinic and home measurements compared to ABPM (€1336/pt and €1473 per patient respectively (P<.001). Cost of blood pressure measurement alone was higher in ABPM than home monitoring at €516 and €393 respectively (P<.001). Although ABPM represented a higher cost in measuring and office visits, it prevented unnecessary treatment in white coat hypertension.

Using Canadian Hypertension Education Program (CHEP) grading algorithm, Daskalopoulou et al. (2015) determined routine manual blood pressure readings are on average 9/6 mmHg higher when compared with research-quality manual blood pressure measurements. White-coat hypertension ranges in prevalence from nine to 30% and routine measurements not performed to standard contribute to the misdiagnosis of hypertension. For this reason, serial standardized office blood pressure measurement can be used for diagnosis of hypertension but ABPM is the preferred method in the diagnosis of hypertension.

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Hodgkinson et al., (2011) sought to determine the relative accuracy of clinic blood pressure measurements compared to ABPM. A systematic review of the literature was performed and compared with ABPM thresholds of 135/85 mmHg; clinic blood pressure measurements had a mean sensitivity of 74.6% and specificity of 74.6% (95% CI). Clinic blood pressure measurements did not have a sufficient sensitivity or specificity to be recommended as a single diagnostic test in the diagnosis of hypertension. A RCT by Meyers, Godwin, Dawes, et al. (2011) compared the quality and accuracy of manual clinic blood pressure measurements using ABPM as the gold standard in primary care settings. Five-hundred fifty-five patients with systolic hypertension were randomized into use of manual clinic blood pressure measurements (control group) and automated clinic blood pressure measurements (intervention group) using ABPM as the gold standard for diagnosis of hypertension. The control group had a higher blood pressure reading than the intervention group; (149.5 (SD 10.8/81.4(8.3)) and 135.6(17.3)/77.7(10.9) $p<0.001$.

The National Institute for Health and Care Excellence (2011) performed a systematic review to provide the best practice advice on the care of adults with hypertension to include identifying, diagnosing and initiating treatment and monitoring treatment and blood pressure targets. The review of 20 studies compared the sensitivity and specificity of office and home blood pressure measurements using ABPM as the reference standard. The sensitivity and specificity of clinic blood pressure measurements compared to ABPM was 74.62% and 74.61% respectively. Sensitivity and specificity of home blood pressure measurements was 85.65% and 62.44% respectively. There was no statistical difference noted for sensitivity or specificity and home blood pressure

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measurement was determined to be better than clinic blood pressure measurements but neither compared to ABPM.

One article and one cohort study pertaining to hypertension and active duty military were retrieved. Smoley, Smith & Runkle (2008) determined the prevalence of high blood pressure among active duty forces is likely more prevalent than previously considered. Of 15,391 subjects, 13% met the definition for hypertension and 62% met the definition for prehypertension. Grando, Smith, Swanson, et al. (2009) performed a cohort study to determine the relationship between combat deployment-induced stress and hypertension. The study analyzed 36,061 ADSMs. Service members who deployed without combat exposure were less likely to report hypertension than nondeployers; odds ratio: 0.77, 95% CI: 0.67 to 0.89. Deployers with multiple combat exposures were 1.33 times more likely to report hypertension compared with noncombat deployers; 95% CI: 1.07 to 1.65.

Although articles referred to the efficiency of ABPM in determining a hypertension diagnosis, none provided statistical data. It was indicated that recommendation for further research be performed to determine the true efficiency of ABPM in hypertension diagnosis. Overall findings from retrieved articles were evaluated based on levels of evidence suggested by Melnyk and Fineoutt-Overholt (2011). Synthesis of the literature is detailed in the Evidence Table in Appendix C.

Potential Barriers or Supports for Adoption of Best Practice

Potential barriers for adoption of ABPM into practice are healthcare provider resistance to change, patient compliance in wear of the monitoring device related to discomfort and/or inconvenience, soldiers perceived delay in care by not coming into the

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clinic daily for measurements and being referred within the healthcare system but out of their clinic. Another barrier to use of ABPM is the need to train staff to fit the monitoring device (Haws, 2015).

Supports for adoption of ABPM into clinical practice include healthcare provider awareness and attitudes in provision of quality care to soldiers, desire to bridge the gap between evidence and practice, healthcare provider ability to place referral into EMR without limitations on durable medical equipment prescribing, availability of monitors within the MTF, and the soldiers' limited time away from the work area with minimal impact on mission accomplishment (Army Regulation 40-501, Department of the Army, 2007).

Summary

This chapter discussed the search strategy and described the results in a table format, and analyzed and synthesized the evidence. Evidence reviewed by USPSTF (2015), Logan et al., (2016) and NICE (2012) supports the use of ABPM in the confirmation of and as an effective strategy in the diagnosis of hypertension. Potential barriers and supports of implementation of ABPM into clinical practice were also discussed.

Chapter 3

Methods

This chapter discusses the methodology of the process improvement DNP project, including the design, unit of analysis, sample, setting, outcomes to be measured, and strategies to reduce barriers and increase supports. The tools, procedure, and data analysis plan are also described.

A proposal for this project was submitted to the Regional Human Protections Administrator (HPA) who covers research at the project location. The Regional HPA determined that this project did not meet the definition of human subject research or the definition of research. The proposal was then presented to the Performance Improvement Committee and the Chief Nursing Officer at the project location. Approval to perform this process improvement DNP project was then granted by the Chief Nursing Officer of the MTF at the project location with the caveat that only de-identified data will be presented for the project. The committee chair for the process improvement DNP project has a copy of approval on file.

Setting

This project was conducted during the academic year 2017 on an Army base at a MTF located in the central United States. This facility is a DoD entity and has a troop population of approximately 26,000 soldiers. On average, each of the four primary care clinics provides primary care to approximately 200 to 250 patients per day to include

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visits for acute, routine, and preventive care. The general troop population ranges in ages from 18 to 54 years old.

Design

This process improvement DNP project used a retrospective chart review to compare two methods for hypertension diagnosis and follow up visit among ADSMs in a primary care clinic. These methods were the standard protocol 5-day method and the 24-hour ABPM method for diagnosing hypertension. In retrospective designs, the outcome of interest has already occurred at the time the study is initiated. Multiple measurements method for use in diagnosing hypertension is well established and highly utilized in primary care clinics. Use of ABPM is the recommended method for diagnosing hypertension but is less established in clinical practice. Criteria for inclusion were gender, both male and female, ages18 to 54 with a diagnosis code of R03.0; elevated blood pressure without a diagnosis of hypertension as defined by a systolic reading >140 mmHg, a diastolic reading >90 mmHg or both. Recommendations for this project are based on a retrospective review of EMRs.

Unit of Analysis

The unit of analysis for this project was measured in days from presumptive to definitive diagnosis of hypertension. The first day began when the soldier was given the diagnosis code R03.0, elevated blood pressure without a diagnosis of hypertension, and prescribed a method of diagnosis by their healthcare provider. The last day was when the soldier completed the prescribed method and had a follow up visit with their healthcare provider to determine whether or not they had a diagnosis of hypertension.

Sample

The clinic location the process improvement project was conducted provides primary care to approximately 2,500 soldiers who range in age from 18 to 54. The soldiers assigned to care at the clinic are members of a unique combat arms organization, are highly motivated, physically fit, mentally tough and highly trained with specialized skills. The soldiers are rapidly deployable to strategic locations across the world. The target population for this project included Active Duty soldiers who sought primary care at the project location between the dates of June 2016 and May 2017 and received an ICD-10 diagnosis code of R03.0: elevated blood pressure without a diagnosis of hypertension will be included. Only males and females with the R03.0 diagnosis code between the ages of 18 to 54 were included. A sample size of 128 records achieves 80% power with a medium effect size and a significance level (alpha) of 0.050 using a tow-sided t-test.

Inclusion Criteria:

- ADSM with an ICD-10 diagnosis code of R0.30: elevated blood pressure without a diagnosis of hypertension.

- age range: 18-54

- male and female

- used 5-day blood pressure measurement method

- used 24-hour ambulatory blood pressure monitoring method

Exclusion criteria:

- missing data

- recommended method incomplete

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- completed both methods

- no follow-up with healthcare provider

Measured Outcomes

The following outcomes were measured, in calendar days, for the 5-day blood pressure check method; a) provider suspicion of hypertension and order of 5-day blood pressure check, b) number of days for ADSM to complete 5-day blood pressure check, and c) ADSM and results followed up with healthcare provider. Measured outcomes for use of ABPM method in calendar days were; a) healthcare provider suspicion of hypertension and placement of referral for ABPM, b) ADSM appointment with Cardiology for fitting of monitor, c) ABPM returned by ADSM to Cardiology, d) ADSM and results followed up with healthcare provider (Appendix D and Appendix E).

Strategies to Reduce Barriers and Increase supports

Expecting all members of a group to accept change at the same time is unrealistic. In healthcare, change occurs constantly and rapidly. It is important to tailor health care delivery to the needs of the local population. Educating and training healthcare providers in the latest recommendations from the USPSTF (2015), JNC7 (2003) and JNC8 (2014) are effective strategies in reducing resistance to change in clinical practice. Providing education and support on the use of and procedure for ABPM to soldiers by healthcare providers prior to placing a referral for fitting of device has the potential to increase compliance with wear of the monitoring device. Therefore, when the soldier is fitted for the device at the Cardiology department, the soldier receives detailed instructions on wear of the device further reinforcing education already provided. To decrease a soldier's perceived delay in care if they are referred for ABPM, healthcare providers provide an

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explanation of the difference between the two methods and reinforce to the soldier the accuracy and efficiency of the ABPM method compared with the 5-day blood pressure measurement method.

Tools

Electronic Medical Record

The EMR at the project location was used to obtain de-identified patient information. The EMR holds data pertaining to each encounter the subject has with the medical system to include vital signs, purpose of visit, healthcare provider recommendations and diagnoses.

Subject Data and Outcomes to be Collected Collection Tool (Appendix D)

Demographic characteristics were obtained from the EMR. Dates were recorded and included the first calendar day the soldier was suspected of having hypertension and ended with the last calendar day the soldier followed up with their healthcare provider to determine a diagnosis of hypertension.

Demographic characteristics include age, gender, race and/or ethnicity, height in inches, weight in pounds, body mass index and blood pressure measurement. The recommended method of blood pressure measurement was also recorded to compare the number of calendar days it took from the time of hypertension suspicion to the date of follow up with the healthcare provider.

Excel Spreadsheet (Appendix E)

An Excel spreadsheet was used to perform descriptive statistics. Demographic characteristics and measured outcomes used to populate the Excel spreadsheet.

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Procedure

Data collection and analysis proceeded in three phases. First, medical records with an ICD-10 diagnosis code of R03.0; elevated blood pressure without a diagnosis of hypertension were requested from the Clinical Support Division at the MTF who stores this information. During phase two, an encrypted list of potential subjects was e-mailed to the DNP student. Requested data was randomly selected. Randomization occurred by selecting every third subject and included encounters from all types of healthcare providers that included Physicians, Physician's Assistant, and Family Nurse Practitioners. The Advanced Practice Registered Nurse (APRN) is a licensed and privileged practitioner and, as such, co-signature by a physician or other privileged provider of APRN entries in the patient's medical record, prescriptions, and so forth, is not required (U.S. Department of the Army, 2009).

Only EMR encounters identified using inclusion criteria were included. The record was reviewed for completeness including a diagnosis code of R03.0, a recommendation for 5-day blood pressure measurement or referral for ABPM, and a follow up visit with a healthcare provider with review of results noted. Five-day blood pressure measurements or ABPM measurements not completed or followed up with a healthcare provider were excluded. Encounters that had both 5-day check and ABPM performed were also excluded. After randomization and inclusion criteria were met, phase three began. In phase three, de-identified data was collected (Appendix D) and entered onto an Excel Spread Sheet (Appendix E) for data analysis. No names or other identifying information was transcribed.

The collected data included: a) initial date the ADSM was identified as needing further assessment for a diagnosis of hypertension; b) number of calendar days it took for an identified ADSM to complete a prescribed blood pressure method assessment; c) number of calendar days it took the ADSM to go from healthcare provider referral to their initial Cardiology Procedures appointment for fitting of a blood pressure monitor; and d) number of days it took for the ADSM, regardless of method used, to follow up with their healthcare provider to review the results. Other demographic data collected included age, gender, race and/or ethnicity, height, weight, BMI and blood pressure recorded in specific encounter that triggered the healthcare provider's suspicion of hypertension. At the conclusion of the project, results were presented to the healthcare providers of the clinic where the project was conducted (see Appendix D).

Data Analysis

Descriptive statistics were used to examine and compute all demographic variables. Descriptive statistics include frequency tables for categorical variables, measures of central tendency (mean and median) and measures of spread (standard deviation and range) for continuous variables. Demographic data included subject age, gender, race and/or ethnicity, height in inches, weight in pounds and body mass index (BMI). The blood pressure measurement that triggered the healthcare provider's suspicion and referral for further blood pressure evaluation will also be included. Inferential statistics included T-test, Chi-square, and Pearson and Spearman correlation P-values less than or equal to .05 were considered significant. Data analysis included both descriptive and inferential statistics using SAS 9.4.

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Summary

The methodology selected for this project was retrospective chart review. This chapter presented the project design, unit of analysis, sample, setting and inclusion criteria for the sample. The IRB approval process, measured outcomes and strategies to reduce barriers and increase supports were also discussed. Data analysis using descriptive statistics was used to compute data to determine recommendations for practice. In Chapter four, the results of this project are discussed.

Chapter 4

Results

The purpose of this project was to determine the most efficient method of diagnosing hypertension among active duty soldiers at a local MTF. The PICOT question addressed in this project was *When diagnosing 18 to 54 year old active duty soldiers with hypertension, how does implementation of 24-hour ambulatory blood pressure monitoring compare to the current protocol of 5-day blood pressure checks in improving the efficiency of a hypertension diagnosis and time to follow up visit?*

Approval to perform this process improvement DNP project was granted by the Chief Nursing Officer of the MTF at the project location with the caveat that only de-identified data will be presented for the project. The committee chair for the process improvement DNP project has a copy of approval on file.

Results from the data analysis are presented in this chapter. The findings include a) frequency distribution of demographic characteristics; b) overall mean, standard deviation and range, c) group mean, standard deviation and rang by group, and d) difference between ABPM and 5-day blood pressure checks. The sample consisted of 128 active duty soldiers' health care records on a military base located in the central United States. Statistical analyses were performed using SAS 9.4 and included descriptive statistics, t-tests, and chi-square. All tests were set at a statistical significance of p<.05.

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Description of Sample

For the project designated period of time, 128 medical encounters were randomly selected meeting both inclusion and exclusion criteria. Sixty-five charts (50.78%) utilized ABPM as a measurement method and 63 charts (49.22%) utilized 5-day blood pressure checks. Table 4 summarizes the demographic characteristics. The sample consisted of 117 (91.41%) males and eleven (8.59%) females. The sample is representative of the combat focused troop population at the project location with majority of soldiers being male and assigned to combat arms units. Race and/or ethnicity included soldiers who identified as African-American (22.66%), White (56.25%), Hispanic 14.84%), Asian (0.78%), American Indian and/or Alaska Native (3.13%), and Native Hawaiian or Pacific Islander (2.34%). The race and/or ethnicity of the sample mirrored the military population at the project location. Approximately 53% (n=73) of the sample received a definitive diagnosis of hypertension following ABPM or 5-day blood pressure checks. Table 4.1 displays the frequency distribution of the demographic characteristics, blood pressure study group and diagnosis of the sample from this project.

The mean age of the 128 sample was 35.23 (SD 8.74) ranging from 19 to 54 years old. The age of the sample represented the overall troop population at the project location. The mean height was 69.47 (SD 3.20) ranging from 62 inches to 77 inches. The mean weight was 198.44 (SD 30.64) ranging from 130 to 272 pounds. The mean BMI was 28.84 (SD 3.40) ranging from 21.96 to 38.22 kg/m2. The BMI is calculated by weight in kilograms and height squared in centimeters. Healthy BMI is 18.5 to 24.9 kg/m2. Overweight is a BMI of 25.0 to <30 kg/m2. A BMI >30 kg/m2 is considered obese.

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Table 4.1 Frequency Distribution of Demographic Characteristics, Blood Pressure Group Study

Variables	Total N	%
Gender		
Male	117	91.41
Female	11	8.59
Race		
African-American	29	22.66
Asian	1	0.78
White	72	56.25
American Indian/Alaska Native	4	3.13
Hispanic	19	14.84
Native Hawaiian/Other Pacific Islander	1	2.34
Group	65	50.78
24-H ABPM	63	49.22
5-day BP check		
Diagnosis		
Hypertension	73	57.03
No Hypertension	55	42.97

Analysis of PICOT Question

Table 4.2 summarizes the overall mean, standard deviation, and range of all

variables.

Table 4.2 Overall Mean, Median, Mode, Standard Deviation (SD), and Range, Blood Pressure Study

Variable	N	Mean	Median	SD	Minimum	Maximum
Age	128	35.23	34.50	8.74	19.00	55.00
Height	128	69.47	70.00	3.20	62.00	77.00
Weight	128	198.44	198.00	30.64	130.00	272.00
BMI	127	28.84	28.48	3.40	21.96	38.22
SBP	128	142.07	142.50	9.33	118.00	165.00
DBP	128	93.23	94.00	8.30	65.00	118.00
Ndsold	128	10.09	7.00	7.70	2.00	47.00
NDpcma	128	8.82	7.00	5.78	2.00	32.00
NDdod	128	18.92	15.00	10.97	6.00	62.00
Tdays	128	37.84	30.00	21.95	12.00	124.00

NDsold-number of days for soldier to complete
NDpcma-number of days from completion to PCM follow-up
NDdod-number of days from initial suspicion to PCM follow up and diagnosis
Tdays-Total number of days

The difference between BMI median (28.48 kg/m2) and mean (28.84 kg/m2) was

minimal. Mean BMI can be raised if data is skewed in one direction however; data

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demonstrates the BMI mean and median are reflective of the sample. The most frequent BMI was 27.44 kg/m2, is multi-modal and not reflective of the sample center of distribution.

Using the JNC7 criteria (Chobanian et al, 2003), hypertension was defined as a systolic blood pressure (SBP) >140 mmHg and/or a diastolic blood pressure (DBP) >90 mmHg. The blood pressure values that initially triggered the healthcare provider's suspicion and decision for further assessment is based on this definition of hypertension. For the sample used, the SBP mean was 142.07 (SD 9.33) ranging from 118 to 165 mmHg. The DBP mean was 93.23 (SD 8.30) ranging from 65 to 118 mmHg.

Data were analyzed using descriptive statistics, t-test and chi-square. Table 4.3 displays the difference in variables between ABPM and 5-day blood pressure checks. There was no statistical significance in group means for ABPM and 5-day blood pressure checks by age, height, weight, BMI, SBP or DBP. The mean SBP for ABPM 141.9 (SD 8.57) was slightly lower than 5-day blood pressure checks 142.3 (SD 10.12). The distribution between the median and mode is not normal. The mode does not reflect the center of distribution in the number of days for the sample. Statistical significance was noted between number of days for completion of prescribed method for diagnosis and for the soldier to complete the prescribed method (NDsold) $p<.001$, number of days from completion check to healthcare provider appointment (NDpcma) $p<.0001$, number of days from initial provider suspicion to soldier follow-up with healthcare provider for decision of diagnosis (NDdod) $p<.0001$ and total number of days to complete the prescribed method and follow up (Tdays) $p<.0001$. Results indicated that ABPM was more efficient in diagnosing hypertension than the 5-day blood pressure check method.

Table 4.3 Group Mean, Median, Mode, Standard Deviation (SD), and *p*-Value, Blood Pressure Study

			24-H ABPM					5-Day BP			
Variable	N	Mean	Median	Mode	SD	N	Mean	Median	Mode	SD	*p*-Value
Age	65	37.77	38.00	38.00	8.05	63	32.62	31.00	27.00	8.72	.007
Height	65	69.37	70.00	71.00	3.26	63	69.58	70.00	68.00	0.40	.7118
Weight	65	199.0	195.00	160.00	27.86	63	197.9	200.00	210.00	33.47	.8426
BMI	65	29.00	28.82	29.29	3.00	63	28.66	28.13	27.4	3.79	.5793
SBP	65	141.9	142.00	146.00	8.57	63	142.3	143.00	147.00	10.12	.8275
DBP	65	94.48	94.00	92.00	8.27	63	91.95	93.00	92.00	8.20	.0854
NDsold	65	5.46	5.00	6.00	2.11	63	14.87	13.00	9.00	8.43	<.0001
NDpcma	65	6.73	6.00	3.00	3.05	63	10.97	10.00	5.00	7.05	<.0001
NDdod	65	12.22	12.00	11.00	3.67	63	25.84	24.00	25.00	11.70	<.0001
Tdays	65	24.42	24.00	22.00	7.35	63	51.68	48.00	50.00	23.40	<.0001

*No pregnant clients were included in data collection or analysis

NDsold-number of days for soldier to complete
NDpcma-number of days from completion to PCM follow-up
NDdod-number of days from initial suspicion to PCM follow up and diagnosis
Tdays-Total number of days

Table 4.4 summarizes the difference between ABPM and 5-day blood pressure

checks and gender, race and/or ethnicity and diagnosis using the chi-square test.

Table 4.4 Difference Between 24-H ABPM and 5-Day BP Checks (Using the chi-square test)

Variable	24-H		5-Day		Chi Square Test
	N	%	N	%	*p*-value
Gender					
Male	59	90.77	58	92.06	.7939
Female	6	9.23	5	7.94	
Race/Ethnicity					
African-American	16	24.62	13	20.63	.3021
White	38	58.46	34	53.97	
Hispanic	6	9.23	13	20.63	
Other	5	7.69	3	4.76	
Diagnosis					
Hypertension	35	53.85	38	60.32	.4594
No Hypertension	30	46.15	25	39.68	

A chi-square test was performed and no statistically significant relationship was found between ABPM and 5-day blood pressure checks and gender (p= .7939), race and/or ethnicity (p= .3021), or diagnosis (p=.4594). These results indicate there was no difference in group means for either method for race, gender and definitive diagnosis.

Summary

In this chapter a description of the sample and statistical analysis of the data was provided. The project sample was representative of the current military population by age, gender, and race. The sample BMI mean was 28.84, categorized as overweight. Weight is a modifiable risk factor in the development of hypertension. The project purpose was to determine the most efficient method to diagnosis hypertension. Use of ABPM was determined to be statistically significant when compared to 5-day blood pressure checks in determining a diagnosis of hypertension indicating that ABPM was more efficient in diagnosing hypertension than the 5-day blood pressure check method.

Chapter 5

Discussion

In this chapter a discussion of the findings are presented. Recommendations for practice, policy, research and education are also discussed.

Discussion of Findings

Use of ABPM in diagnosing hypertension has been proven in research and is recommended in clinical practice in confirming the diagnosis of hypertension prior to initiation of treatment (USPSTF, 2015). The results of this process improvement project answered the question if use of ABPM is more efficient than 5-day blood pressure checks method in determining a diagnosis of hypertension at a local MTF. This project reinforces the literature and provides data supporting implementation of ABMP use into clinical practice at the project location.

The mean number of days to determine a diagnosis in the 5-day blood pressure sample was 25.84 compared to ABPM mean of 12.22 days. Current clinical practice utilizes 5-day blood pressure checks to determine a hypertension diagnosis. This method is time-consuming and based on the project data, delays diagnosis and treatment if required. Using the 5-day blood pressure method requires approximately seven primary care visits. The visits began the day the soldier is notified on the need for further assessment and is not considered to be complete until the prescribed method for blood pressure monitoring is completed and the soldier has a follow up with a healthcare

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provider to determine a diagnosis. A delayed hypertension diagnosis has health consequences that include heart attack, stroke, vision loss, and kidney damage.

The ABPM sample demonstrated a mean 12.22 days to determine a diagnosis of hypertension. This is the recommended method by the USPSTF (2015) and takes approximately three primary care visits. During the data collection phase, the DNP candidate noted that many of the ABPM results were followed up via telephone consult to advise the soldier they did not have a diagnosis of hypertension and did not require a follow up visit with their healthcare provider, further reducing the number of visits the soldier had to make to the clinic. Very few of the telephone consult encounters provided education on lifestyle modifications; diet and exercise, in the prevention of prehypertension or hypertension. Based on the current literature, the findings from the project data were expected.

Hypertension is a common diagnosis in older populations 60 years and over. Approximately 92% of the military population is under the age of 40. The mean age of the sample was 35.23 years old. Fifty-seven percent (n=73) of the sample received a diagnosis of hypertension. The military is presumed to be young and healthy and an extensive amount of research regarding hypertension in this population is not available. Data does exist on the military population and the relationship to stress, unhealthy diets, tobacco use, alcohol consumption, and stimulants in the form of energy drinks and workout supplements. The data demonstrates that soldiers have a higher exposure to stress related to suboptimal living conditions in deployed environments and combat, use 5% more tobacco in the form of cigarettes, use approximately 9% more smokeless tobacco, and consume 9% more alcohol than the general US population. It was also found

that nearly 45% of soldiers consume at least three energy drinks per day. All are common modifiable risk factors in the development of hypertension and may reflect the higher prevalence of diagnosis among the sample. An unexpected result of the data revealed that the majority of soldiers evaluated in the sample are overweight or obese as determined by BMI. Results demonstrate that BMI values ranged from 21.96 to 38.22 kg/m2 with a mean of 28.84 kg/m2.

Being overweight or obese is another common risk factor in the development of hypertension. Overweight, including obesity in the general population of adults over the age of 20 was 70.7 % in 2014 (CDC, 2017). A BMI value does not distinguish between an individual's muscle mass or fat mass, so an individual who has a high BMI value may either have increased muscle or increased fat. New military data suggests obesity rates among ADSMs are growing at an alarming rate. Approximately 8 % of service members are clinically overweight (Tilghman, 2016). This percentage is up from 2001 when only 1.6 % of ADSMs was considered overweight. Current Army policy requires soldiers to maintain body fat levels below 28 % for men and 36 % for women. If this standard is not met, the soldier is subject to a tape test using a calibrated, non-stretch tape measure. Several measurements are obtained to include waist in men and waist and hips in women. Soldiers who fail to meet the standards are provided with education sessions by MTF registered dieticians and are ineligible for promotion, restricted from certain leadership positions and subject to separation from the Army.

Recommendations for Practice, Research and Education

This project reinforces current research and practice guidelines that ABPM is more efficient than 5-day blood pressure checks. Cost benefit for implementation of the

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ABPM to the military health system requires further research. Associated costs of misdiagnosis and over treatment further impacts the military's ability to meet mission requirements. Lost training and work hours incur secondary effects on deployability and sustainment of human and equipment resources.

With guidance and leadership support, the project findings can be applied to current practice and over time be implemented installation wide for active duty soldiers to improve the health of the fighting force, enhance medical readiness and sustain deployability requirements through rapid diagnosis, initiation of treatment when indicated, and improve clinical outcomes. Healthcare providers will need education on ABPM prior to implementing the project findings into clinical practice. Continuing education forums occur during duty hours and are facilitated by clinical experts contracted by local medical treatment facilities. Clinical updates based on the evidenced-based guidelines in ABPM can be made available via smart phone applications for clinician and patient use through MTF access to free clinical databases. Ancillary service providers such as dieticians, public health professionals, and athletic trainers will also benefit from ABPM updates to reinforce appropriate recommendations provided by the DNP candidate.

Practice recommendations include generating a standard operating procedure (SOP) for the routine screening of soldiers. The SOP should be created utilizing the most current clinical practice recommendations by the USPSTF (2015) and the JNC8 committee. Practice recommendations include the healthcare provider recognizing when to further assess blood pressure, how to appropriately place a referral to Cardiology procedures in the EMR, and provide education and guidance to the soldier on the normal

blood pressure, effect of diet and exercise, and the adjunctive dietary recommendations for control. Furthermore, the purpose and the process for the referral should be reviewed to ensure completion of the treatment recommendations. With regard to the high BMI in the sample, it cannot be assumed that it is a direct correlation to high blood pressure. Measures to ensure appropriate diagnosis of high blood pressure are not based solely on a patient's appearance. Military regulation mandates height and weight as a method of determining BMI. However, in situations where soldiers do not meet BMI standards, healthcare providers have the ability to place a referral to the Army Wellness Center (AWC). The AWC is a part of the MTF and provides services to include metabolic and Bod Pod testing. Bod Pod testing is a body measurement method that measures mass and volume in order to calculate body fat versus lean muscle mass. This is a free service to soldiers and does not require a healthcare provider referral. A healthcare provider may place a referral as part of a soldier's treatment plan. Use of the AWC services is a recommendation to all soldiers who are observed to have a BMI in the overweight or obese category.

Conclusions

This process improvement project sought to determine the efficiency of ABPM compared to 5-day blood pressure checks in an MTF. Using the Iowa Model of Evidence-Based Practice to Promote Quality Care as the framework for the project, a clinical question was formulated and a literature search was performed. Findings from the synthesis of the literature demonstrated there was sufficient evidence to support the project purpose. The project question was aimed towards active duty soldiers at the local MTF. A sample using inclusion and exclusion criteria was obtained. A retrospective chart

review was utilized as the study design. Using the EMR available at the MTF, data was collected and analyzed on the sample population. Statistical analysis of the data demonstrated that use of ABPM was a more efficient method to determine a hypertension diagnosis than use of 5-day blood pressure checks. Finally, recommendations including creation of an SOP and healthcare provider education, implementation of the project at the location can increase medical readiness and improve clinical outcomes. Additionally, dissemination of the project findings can be presented at both the quarterly All Provider meeting; includes all providers credentialed at the MTF who provide care for ADSMs, and to unit leaders and at the installation senior leader brief; to ensure key leaders understand the impact of hypertension on medical readiness and deployability.

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Appendix A

5-Day Blood Pressure Check Form

Patient Name _____   Date of birth _____
Sponsor's last four of SS# _____   Ordering Provider _____

FIVE DAY BLOOD PRESSURE EVALUATION

You may have high blood pressure but your provider needs more than one blood pressure reading to determine this. Your provider needs you to get your blood pressure checked on 5 consecutive days. (It is alright if you miss the weekend days)

You do not need an appointment and you do not need to check in at the front desk for a blood pressure check. Just go to the Nurses Station, check in at the desk, remove any thick sleeve material from both arms, and have a seat. You will sit for 10 minutes before your blood pressure will be taken. (If you stand up for any reason, during the 10 minutes, the time starts over again.)

You may start your 5 day blood pressure any time you want on any 5 days that are convenient. Try to have it done at approximately the same time every day.

Your blood pressure should stay at 130/80 or <. After your third blood pressure check, the nurse will tell you if you need to make a follow-up appointment with your provider. If so, please call and make an appointment. If not, we will put in a T-Con for your provider to include all of the numbers from the checks you had done, and they will be evaluated.

For Active Duty patients, please continue to do PT unless directed otherwise by your Provider with a profile.

DATE	BP LEFT	BP RIGHT	INITIALS

Appendix B

CARDIOLOGY CLINIC
STANDARD OPERATING PROCEDURES
24-HOUR AMBULATORY BLOOD PRESSURE MONITORING

1. **REFERENCES:** Internal Policy, Operator Manual Welch Allen Cardio Perfect

2. **PURPOSE:** To ensure that personnel understand the procedures for 24-Hour Ambulatory Blood Pressure Monitoring.

3. **APPLICABILITY:** All personnel assigned to the Cardiology Clinic.

4. **RESPONSIBILITY:** It is the responsibility of all clinic personnel to read and understand this policy.

5. **PROCEDURE:**

    a. Items needed:
        i. BP cuff (25-35 cm or 39-46cm)
        ii. Monitor
        iii. 2x AA batteries
        iv. Belt and pouch
    b. Setting up the monitor:
        i. Select the Welch Allen Cardio Perfect icon
        ii. Select Login (no login information required)
        iii. Select "Patient" button at top of page and fill in the following patient information:
            1. Number (FMP and SSAN)
            2. Name (last, middle, and first)
            3. Alternate number (DoD identification number)
            4. Gender
            5. Date of birth
            6. Race/Ethnicity
            7. Height/Weight
            8. Select "OK"
        iv. Plug in jack to bottom of BP monitor.

v. Install 2 fresh AA batteries into monitor (monitor requires new batteries for each new test)
vi. Turn off BP monitor (monitor automatically turns on with insertion of batteries)
vii. Select "ABP" button (computer communicates with device if window pops up stating "There is no response from the hardware…" In this instance, fiddle with plug jack and select "Try Again").
viii. Select "Protocol Editor"
ix. Select "Protocol 1" (some numbers and times are displayed):
  1. Under "Time Interval" there is a "20" followed by "60"
     i. "20" time interval is daytime intervals (BP reading every 20 minutes). Change this time to the time the patient will be waking up. Leave the interval at 20 unless otherwise instructed by ordering provider. Leave buzzer checked.
     ii. "60" time interval is nighttime intervals (BP reading every 60 minutes). Change this to the time the patient will be going to sleep. Leave the interval at 60 minutes unless otherwise instructed by ordering provider. Leave buzzer off.
     iii. Choose "Done" when complete.
  2. Max inflation pressure default is 160; raise this to a number higher than the patient's highest known BP reading (i.e. 200). If this is not done, an error message appears whenever the BP is higher than the chosen number.
     i. Choose "OK" and the information is transferred to the monitor.
  3. Write the ECN number of the monitor on the monitor release form.
x. Patient hookup:
  1. Measure arm to make sure appropriate cuff size is used.
  2. Slide cuff band onto patient's non-dominant arm, unless patient desires it otherwise or contraindicated (i.e. Lymph node removal).
  3. Place appropriate BP cuff on patient's arm.
  4. Place monitor in pouch and adjust belt around patient's waist.
  5. Have patient feed line under their garment, around the back of their neck, and out through their shirt sleeve, making sure monitor line does not go under the armpit when connecting to the cuff hose.
  6. Connect cuff hose to the monitor hose.
  7. Have the patient sit and relax their arm. Push blue button (Start/Stop) on monitor twice (once to turn on monitor and once to do an initial BP – monitor will not automatically turn on and take BP without this initiation).
xi. Troubleshooting:
  1. If the monitor fails to capture a BP, it will automatically try again in 5 minutes and continuously thereafter until a it has successfully acquired a BP. If this scenario occurs, look for:
     i. Hose bent/kinked

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        ii.   Arm not straight or still

        iii.   Hose separated from cuff

        iv.   Cuff loosened or slipped below elbow junction

xii.   Downloading monitor after test completed:
1. Turn off monitor and plug in plug jack into bottom of monitor
2. In "Search", type patient's last name or SSAN
3. Choose correct patient
4. In the lower left screen, choose the date and time of test
5. Choose "Read Measurements" (if does not connect, see b. vii)
6. Correct "Patient was asleep from": (sleep time from patient or journal) and "until" (wakeup time from patient or journal); then choose "OK"
7. Report will automatically print out

xiii.   Printing a past report:
1. Login (see b. i and ii)
2. In "Search", type patients last name
3. Choose desired patient
4. Choose desired test date
5. Choose drop-down arrow beside print and choose "Print selected formats ctrl+alt+p"

Appendix C

Evidence Table

PICO Question: *(P)* **When diagnosing 18 to 54 year old Active Duty soldiers with hypertension, *(I)* how does implementation of 24-hour ambulatory blood pressure monitoring *(C)* compare to the current protocol of 5-day blood pressure checks *(O)* in improving the efficiency of a hypertension diagnosis and time to follow up visit?**

Brief Reference	Research Method/ Level of Evidence	Study Purpose	Results/Recommendations	Conclusion
Boubouchairopoulou, Karpettas, Athanasakis, et al.(2014)	Systematic Review of Literature derived from RCT/II	Estimate resources consumed and subsequent costs for hypertension management (initiation and titration) using HBPM, C/ABPM. 116 untreated HTN subjects randomized to use HBPM or C/ABPM for antihypertensive treatment initiation and titration.	No statistical difference between study arms in regard to BP decline, HTN control rate and target-organ damage. Total cost in first year (monitoring and office visits) was lower in HBPM than C/ABPM (€1336/pt and €1473/pt respectively (P<.001). Cost of BP measurement alone was higher in C/ABPM arm than HBPM €516 and €393 respectively (P<.001). Although C/ABPM represented a higher cost in measuring and office visits, it prevented	ABPM is the most effective strategy for HTN diagnosis, cost-savings, and resulting in more quality-adjusted life years and consequently, was recommended for most patients before antihypertensive drug treatment initiation.

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			unnecessary treatment in white-coat HTN	
Chobanian, Bakris, & Black (2003)	Systematic Review/I	Issue guidelines and advisories designed to increase awareness, prevention, diagnosis, treatment, and control of HTN	Review of evidence supporting recommendations using NHBPEP classification scheme. New data on lifetime risk of HTN indicated need for reclassification of BP; includes new term of preHTN defined as BP ranging from 120-139 mmHg systolic and/or 80-89 mmHg diastolic; HTN now defined as systolic >140 mmHg or measurement >90 mmHg; combined stage 2 and 3 into single stage 2 category; use of anti HTN for lowering BP; appropriate office measurement; use of ABPM	The level of BP measurement by using ABPM correlates better than office measurements with target organ injury
Daskalopoulou, Rabi, Zarnke, et al. (2015)	Systematic Review of Literature and RCTs/I	Provide updated 2015 EB recommendations for the prevention, diagnosis, assessment, and treatment of HTN in adults.	Using CHEP grading algorithm (aligned with AGREE-2 guidelines) to review RCTs and Systematic reviews of RCTs studies demonstrate routine manual BP readings are on average 9/6 mmHg higher	In diagnosing HTN, if the visit 1 OBPM is high normal, annual follow-up is recommended. If the

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compared with research-quality manual BP measurements. Prevalence of white-coat HTN ranges from 9% to 30%. Out-of-office measures can identify white-coat HTN and have better predictive ability than OBPM in terms of CV outcomes.

visit 1 mean OBPM is high, a history and PE should be performed and if clinically indicated, diagnostic tests to search for target organ damage and associated CV risk factors should be arranged within visit 2. If the visit 1 mean OBPM is 140-179/90-109 mmHg, out-of-office BP measurements should be performed before visit 2. Serial standardized OBPM can be used for diagnosis of HTN but this method

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				is not preferred. ABPM is the recommended out-of-office measurement method.
Eckel, Jakicic, Ard, et al. (2014)	Systematic Review of RCTs, meta-analyses and observational studies/I	Prevent CVD; improve management of people with CVD; develop guidelines, standards and policies to promote optimal patient care and CV health	Using NHLBI grading format- results from 34 good or fair quality studies demonstrates strong and consistent clinical trial evidence that reducing sodium intake lowers BP. Trials contributing to evidence include well-controlled feeding studies as well as studies in which participants were counseled to lower sodium intake. Systematic review of 15 meta-analyses of fair to good quality demonstrate aerobic physical activity, on average of 3-4 sessions per week lasting on average of 40/min per session, decreases systolic and diastolic BP on average by 2-5 mmHg and 1-4 mmHg respectively.	Effects of diet and aerobic and/or resistance training reduce CVD and prehypertension converting to HTN

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Grando, Smith, Swanson, et.al, (2009)	Cohort Study/IV	Determine relation between combat deployment-induced stress and HTN	77,047 ADSMs completed Millennium Cohort baseline questionnaire (2001-2003). Three years later, (2004-2006), 55,021 responders followed up. After exclusion criteria applied, 36,061 ADSMs were analyzed. Deployers who experienced no combat exposures were less likely to report HTN than nondeployers; odds ratio:0.77, 95% CI: 0.67 to 0.89. Deployers with multiple combat exposures were 1.33 times more likely to report HTN compared with noncombat deployers; 95% CI: 1.07 to 1.65	Newly reported HTN was identified in 6.9% of cohort between baseline and follow-up. Among deployers, those reporting multiple combat exposures were 1.33 times more likely to report HTN compared with noncombat deployers. Deployment with multiple stressful combat exposures appeared to be a unique risk factor for newly reported HTN
Hodgkinson, Mant, Martin, Hobbs, et al. (2011)	Systematic Review with meta-analysis/I	Determine relative accuracy of clinic measurement	Compared with ABPM thresholds of 135/85 mmHg, OBPM over 140/90 mmHg had mean	Clinic nor home measurement had sufficient

		s and HBPM compared with ABPM as a reference standard for the diagnosis of HTN	sensitivity and specificity of 74.6% (95% CI 60.7% to 84.8%) and 74.6% (47.9% to 90.4%)	sensitivity or specificity to be recommended as a single diagnostic test. If ABPM is taken as reference standard, then txt decisions based on clinic or home BPM alone might result in substantial over-diagnosis
Logan, Harris, Dionne, et al. (2016)	Systematic Review of Lit and RCTs/I	Provide updated 2016 EB recommendations for the prevention, diagnosis, assessment, and treatment of HTN in adults	Using evidence graded w/ standardized algorithms developed by CHEP (aligned with AGREE II guidelines) provided recommendations for; accurate measurement of BP to include use of validated equipment for all methods of measurement; criteria for diagnosis of HTN; and standardized	In diagnosing HTN, if the visit 1 OBPM is high normal, annual follow-up is recommended. If the visit 1 mean OBPM is high, a history and PE should be performed

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			protocol for office, home and ABPM.	and if clinically indicated, diagnostic tests to search for target organ damage and associated CV risk factors should be arranged within visit 2. If the visit 1 mean OBPM is 140-179/90-109 mmHg, out-of-office BP measurements should be performed before visit 2. Use of out-of-office measurements (ABPM preferred) should be used to confirm diagnosis of HTN
Lovibond, Jowett, Barton, et al. (2011)	Comparativ e design	Compare three diagnostic strategies;	ABPM was cost-savings for all groups, 95% CI €56 (-105 to -10) in men	ABPM was the most cost-effective

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		OBPM, HBPM, and ABPM, using Markov model-based probabilistic cost-effective analysis, in terms of lifetime costs, quality-adjusted life years, and cost-effectiveness	aged 75 years and €323 (-389 to -222) in women aged 40 years, more quality-adjusted life years for men and women older than 50 years (from 0.006 for women aged 60 years to 0.002 and for men aged 70 years	strategy for the dx of HTN and resulted in more quality-adjusted life years ABPM as a diagnostic strategy for HTN after an initial raised reading in the clinic would reduce misdiagnosis and save costs. Additional costs from ABPM are counterbalanced by cost savings from better targeted treatment
Myers, Godwin, Dawes, et al. (2011)	Randomized Control Trial/II	Compare quality and accuracy of manual OBPM and automated OBPM using ABPM as gold standard in primary care setting	555 patients with systolic HTN (using most recent routine manual OBPM) randomized into use of manual office BP (control) or automated office BP (intervention); using ABPM as the gold standard for	Automated OBPM compared to ABPM significantly better when compared to manual OBPM

			diagnosis of HTN; Control group BP (149.5 (SD 10.8/81.4(8.3), was higher than intervention group BP 135.6(17.3)/77.7(10.9) P<0.001. Routine manual OBPM readings correlated poorly with the ABPM standard	
National Institute for Health and Care Excellence (2011)	Systematic Review/I	Provide best practice advice on care of adults with HTN to include identifying, diagnosing, initiating treatment and monitoring treatment and blood pressure targets	Systematic review/meta-analysis of 20 studies (N=5863) comparing sensitivity and specificity of C/HBPM measurements using ABPM as the reference standard; 95% CI Sensitivity-OBPM compared to ABPM 74.62%, HBPM compared to ABPM 85.65%, Specificity-OBPM compared to ABPM 74.61%, HBPM compared to ABPM 62.44%, no statistical difference noted for sensitivity or specificity	HBPM is a better measurement than clinic BP for diagnosing HTN but not as good as ABPM. Confirming a diagnosis of HTN w/ ABPM instead of clinic or home BPM was the most cost-effective option in all age/gender groups to include long term costs d/t HTN treatment costs

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				avoided d/t more accurate diagnosis (increased specificity)
Pickering, Hall, Appel, et al. (2005)	Systematic Review/I	Recommendations for blood pressure measurement	Studies compared prognostic importance of ABPM to OBPM with ABPM superior to OBPM. In practice, BP measurement remains suboptimal. Regulatory agencies should establish standards to ensure the use of validated devices, routine calibration of equipment and the training and retraining of manual observers	Although ABPM could be used to monitor therapy, the most common application is diagnostic. Twenty-four hour ABPM gives a better prediction of risk than office measurements and is useful for diagnosing white-coat HTN
Piper, Evans, Burda, et al. (2015)	Systematic Review/IV	Update systematic review on benefits and harms of screening for high blood pressure in adults and summarize	Four good-quality and three fair-quality studies examined diagnostic accuracy of OBPM compared w/ manual sphyg. as reference standard; reported sensitivities of OBPM ranged from 51% to 68%.	Evidence supports ABPM as the reference standard for confirming elevated office BP screening

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		evidence on re screening intervals and diagnostic accuracy of different BP methods	One study had reported sensitivity of 91% but differed from others for using higher threshold in definition of elevated BP. Three studies compared manual and automated OBPM with ABPM as reference standard, neither OBPM results were clearly favored.	results to avoid misdiagnosis and overtreatment
Shimbo, Abdalla, Falzon, et al. (2015)	Systematic Review of Lit/I	Describe ABPM procedures, BP measurements obtained using this method and current evidence supporting the use of ABPM in clinical practice	Review of CPG published since 2011 recommending clinical use of ABPM in diagnosis of HTN; NICE (2011), ACC/AHA (2011), ESH/ESC (2013), CHEP 92014), ASH (2014), JNC8 (2014), AHA/ACC/CDC (2014) and USPSTF (2014)	Evidence supports confirming HTN with ABPM except in patients whom immediate treatment initiation may be indicated (BP reading of 180/110 mmHg or higher)
Smoley, Smith, and Runkle (2008)		Determine prevalence of high BP in Armed Forces	13% of 15,391 subjects met the study definition for HTN and 62% met the study definition for prehypertension	HTN and prehypertension are more prevalent in the US Armed Forces than has been

			previously reported
US Preventive Services Task Force (2015)	Systematic Review/I	Examination of the diagnostic accuracy of office BP measurement, ABPM and HBPM	Four fair to good quality studies identified using guidelines. One good quality study compared manual anaeroid sphyg. (as reference) with automated oscillometric device in 399 randomly selected middle-aged men and women w/ higher BP; Oscillometric device had 91% sensitivity, 96% specificity and 88% PPV. Two good-quality studies compared manual mercury sphyg. w/ oscillometric device in 509 adults w/ similar results; 59% and 68% sensitivity, 98% and 96% specificity and 84% and 79% PPV. One fair-quality study compared mercury sphyg w/ oscillometric device 51% sensitivity, 97% specificity and 76% PPV	ABPM is the reference standard for confirming the diagnosis of HTN
Department of Veterans Affairs	Systematic Review of Lit/I	To assist healthcare providers in all aspects of	Data and recommendations obtained from systematic review of	Offer ABPM as alternate for confirming

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		outpatient care for patients with HTN.	literature. Recommend diagnosis of HTN be determined based on at least two blood pressure readings on two separate patient visits.	dx of HTN in patients with persistently elevated office blood pressure.
Weber, Schiffrin, William, et al. (2013)	Systematic Review of Lit/Professional Statement/ V	Provide a straight-forward approach to diagnosing and managing HTN in the community	Use of electronic device in measuring BP is preferred because it provides more reproducible results than the older method and is not influenced by variation in technique or by the bias of the observers	Because some patients may have BP that is higher in the clinic or office but are normal elsewhere, use of HBPM or ABPM is recommended

Key

ABPM-Ambulatory blood pressure monitoring
BP-Blood pressure
CBPM-Clinic blood pressure monitoring
CI- Confidence Interval
CV-Cardiovascular
CVD-Cardiovascular disease
EB-Evidence-based
HBPM-Home blood pressure monitoring
HTN-Hypertension
MI-Myocardial infarction
NHLBI- National Heart, Lung, and Blood Institute
PE-Physical exam
RCT-Randomized Control Trial

Appendix D

Subject Data and Data Points to be Collected

Subject ID: _ _ _
_____5-day B/P Check   _____24-h ABPM

Age: _____   Gender: ☐ Male ☐ Female

Race: ☐ African American ☐ Asian ☐ White ☐ American Indian/Alaska Native ☐
Hispanic ☐ Native Hawaiian/ Other   Pacific Islander

Height (inches): _____   Weight (pounds): _____   BMI:
_____

Systolic Blood Pressure: _____   Diastolic Blood Pressure:
_____

Measured Outcomes

5-day B/P Check

1. Initial suspicion of HTN; healthcare provider gives instructions to ADSM on 5-day blood pressure measurements-(Day 1)
2. Number of days it takes for ADSM to obtain 5 blood pressure measurements
3. Number of days for ADSM to complete 5 blood pressure measurements
4. Number of days it takes for ADSM and results to be followed up with healthcare provider

24-h ABPM

1. Initial suspicion of HTN; healthcare provider places referral to cardiology-(Day 1)
2. Number of days from referral placement to cardiology contacting ADSM with appointment date and time

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3. Number of days from referral to ADSM fitting with monitoring device
4. Number of days it takes for ADSM to return monitoring device
5. Number of days for Cardiologist to interpret monitoring device results
6. Number of days it takes for ADSM and results to be followed up with healthcare provider

Appendix E

Excel Spreadsheet

Subject ID	5-Day	ABPM	DOB	AGE	GENDER	RACE	HT	WT