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Back to Basics: Improving the Quality of Blood Pressure Measurement

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Getting Back to Basics: Improving the Quality of Blood Pressure Measurement

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Abstract

Practice Problem: Hypertension is a leading cause of death and disability worldwide. Blood pressure measurement (BPM) is at the forefront of diagnosing and treating hypertension, however, it is often measured inaccurately.

PICOT: The PICOT question that guided this project was: In outpatient adult patients (P), what is the effect of implementing a standardized blood pressure measurement protocol (I) versus standard measurement (C), on the quality of blood pressure measurement (O) within 8 weeks (T)?

Evidence: Implementation of a blood pressure measurement protocol has been shown to improve the quality of blood pressure measurement.

Intervention: A blood pressure measurement protocol was implemented to improve the quality of blood pressure measurement.

Outcome: The intervention improved the quality of blood pressure measurement, complying with the clinical practice guidelines, from a mean of 5 techniques to 9 techniques. Additionally, the number of Primary Care patients with HTN decreased from 37% to 33%, and the number of patients with normal blood pressure increased from 63% to 67%, ultimately improving the Primary care HTN metric from 66% to 71% during this project.

Conclusion: The protocol not only improved the quality of the blood pressure measurement, but it also improved the hypertension metric. It is an effective intervention to improve the quality of blood pressure measurement, and the confidence in treating and managing hypertension.

Improving the Quality of Blood Pressure Measurement

Nearly one in three Americans aged 18 years and older have been diagnosed with hypertension (Tice et al., 2019). Blood pressure measurement (BPM) is at the forefront of diagnosing and treating hypertension, however, it is often measured inaccurately (Matheson et al., 2020). The quality of the BPM is imperative as it leads to treatment decisions, whether appropriate or inappropriate (Tice et al., 2019). It is unknown how many patients have been misdiagnosed and incurred unnecessary treatment, and how many have been undiagnosed and incurred treatment delays as the result of poor-quality BPM (Bhatt et al., 2016). The purpose of this project proposal was to explore a practice problem of poor-quality BPM, identify a PICOT question to drive evidence-based practice (EBP) change, describe the EBP framework and change theory used to guide the EBP change, conduct an evidence search, identify themes with practice recommendations, and implement and disseminate an EBP change project.

Significance of the Practice Problem

Hypertension (HTN) is the leading cause of death and disability worldwide (Hwang et al., 2018), affecting about 103 million adults in the US and over a billion people globally (Muntner et al., 2019-a). HTN costs the nation about $46 to $55.9 billion annually through healthcare services, medications, and missed work highlighting the need for accurate BPM and diagnosis (Matheson et al., 2020; Muntner et al., 2019-a; Over, 2020). It is the leading modifiable risk factor for morbidity and mortality associated with cardiovascular disease, accounting for about 10.4 million deaths per year (Tocci et al., 2022; Unger et al., 2020). The BPM is the clinical assessment for diagnosing and chronically managing HTN (Stergiou et al., 2021). As important as BPMs are in the clinical setting, it is often measured inaccurately (Matheson et al., 2020).

The HTN metric was identified as a strategic area of improvement by primary care leadership for the fiscal year 2023, as the metric was below the national benchmark. VA uses the Strategic Analytics for Improvement and Learning Value Model (SAIL) to summarize hospital performance, and the facility was ranked low in the 4th quintile of 5. One of the primary care floors has about 10,500 patients assigned to the 14 clinics (VHA Support Service Center, 2023), about 3,100 patients diagnosed with HTN, and 1,032 patients failing HTN management (Electronic Quality Measurement, 2023), meaning they have a BPM of 140/90 or higher (VHA Support Service Center, 2023). Of the 14 clinics, only one has consistently met the HTN management goal of 66%, meaning that 66% of the clinic's patients diagnosed with HTN have a BPM of less than 140/90 (VHA Support Service Center, 2023). An analysis was completed to investigate what could be contributing to this low compliance. Observations were made in the primary care area and noted various techniques in obtaining the BPM among staff. It was further noted that there was no standardization of the BPM process. It was observed that patients were often rushed into their appointment, vital signs were taken while talking and completing clinical reminders, patients were not allowed to rest before BPM, patients were not positioned appropriately, staff was not ensuring proper cuff size or placement, and staff lacked knowledge of the American Heart Association's (AHA) clinical practice guidelines (CPG). These observations noted zero compliance with the AHA's CPGs for BPM, which could have contributed to poor quality and inaccurate readings.

Obtaining a BPM is a basic assessment skill learned in nursing school (Brown et al., 2019); however, many nurses fail to follow the AHA guidelines regarding BPM, which leads to poor-quality and inaccurate BPM and ultimately mismanagement of patient care with unnecessary treatment or delays, exposure to preventable cardiovascular disease, and patient safety issues (Matheson et al., 2020). Early detection of HTN through high-quality and accurate BMP can delay or even prevent end-organ damage by protecting vital organs such as the heart, brain, kidneys, and eyes. Poor quality BPM can lead to misdiagnosis, underdiagnosis, misrepresentation, and inappropriate care, and trust can be lost between the patient, provider, and the healthcare system (Tice et al., 2019). The healthcare system is impacted by lost revenue from patients choosing to receive care elsewhere, and by legal implications for misdiagnosis, mistreatment, or delays in care. Costs for annual HTN treatment, and associated cardiovascular diseases, per event average $444, myocardial infarction $21,439-$24,523, stable angina $2,144-$2,452, unstable angina $12,863-$14,714, and stroke $15,749-$19,083; and annual maintenance costs for these conditions are noted as $4490, $449, $2694, and $5401 respectfully (Beyhaghi & Viera, 2018). Society is impacted by the cost of hypertension care with an average cost of $55.9 billion a year in the US (Matheson et al., 2020). Despite global healthcare policy regarding hypertension, inaccuracies in BPM persist (Campbell et al., 2020). Ethical issues exist when healthcare providers are against time constraints, rushing BPMs, or not following guidelines leading to misdiagnosis and unnecessary or missed treatment options (Brown et al., 2019).

The prevalence of HTN related to inaccurate BPM is unknown (Bhatt et al., 2017). Several studies have cited multiple causes of inaccuracies that account for upwards of 97% of all BPMs failing to meet AHA protocolized recommendations including up to 36% of all blood pressure measurements taken with the wrong-sized cuff (Matheson et al., 2020). Any deviation from the AHA guidelines usually results in falsely elevated BPM (Hwang et al., 2018). The American Medical Association (AMA) (2019) estimates suboptimal BPM in 20-45% of cases, an inaccuracy that has persisted despite extensive education and awareness efforts.

The standard location for BPM is the brachial artery, as the more distal arteries result in increased systolic pressure and decreased diastolic pressure (Ogedegbe & Pickering, 2010). Interestingly, BPM changes by 2 mmHg for every inch the patient's arm is above or below the heart, with falsely elevated measurements if the arm is below the right atrium and falsely low measurements if the arm is above the right atrium (Matheson et al., 2020). Another study noted the prevalence of incorrect cuff size at 39%, resulting in measurements being 4.8-19.7 mmHg higher than what they should have been (American Heart Association, 2022). To put a small error into perspective, an overestimate of BPM by 5 mmHg results in erroneous diagnosis and unnecessary treatment of hypertension for 27-84 million patients; whereas an underestimate of 5 mmHg would delay diagnosis and treatment for about 21 million patients who have undiagnosed hypertension (Berg, 2019; Over, 2020). With the slightest deviation from the BPM guidelines, incorrect measurements can be made, thus emphasizing the need for a standardized process (Muntner et al., 2019-b).

PICOT Question

The PICOT that guided this project was: In outpatient adult patients (P), what is the effect of implementing a standardized blood pressure measurement protocol (I) versus standard measurement (C), on the quality of blood pressure measurement (O) within 8 weeks (T)?

Population

The population of adults aged 18 and above, included both men and women Veterans seen in one floor of the outpatient primary care clinic setting within a large government healthcare facility in Southern California. This medically complex Veteran population had multiple comorbidities, where exposure to environmental and psychological stressors during their service and genetic components create a very special population, unlike their civilian counterparts (Olenik et al., 2015).

Intervention

Implementation of a standardized process, in the form of a protocol, in obtaining BPM included the use of an automated and validated device, proper preparation of the patient, five minutes of rest before obtaining the BPM, correct positioning of the patient before and during BPM, selecting the correct size and position of the BP cuff during measurement, and documenting appropriately in the medical record. This pilot program was conducted on one floor of the primary care clinics. The training process included education on the protocol to all RNs and LVNs and a review of the appropriate cuff size selection and placement. Evidence and practice guidelines supported this intervention, noted later in the literature review. By obtaining a high-quality and accurate BPM through a standardized protocol, the quality of measurement was expected to improve.

Comparison

The current BPM was unstandardized. Observation of the process noted multiple variations with varied lengths of patient rest before obtaining a measurement, inconsistent patient preparation and positioning, staff and/or patient talking during measurement, incorrect BP cuff size and position, and improper documentation in the medical record. No protocol existed.

Outcome

The expected outcomes were that the BPM using a standardized protocol would result in adherence to CPGs and that there would be an improvement in the quality and accuracy of the measurement. The long-term goal was to see an improvement in the primary care hypertension metric as high-quality and accurate BPM is obtained.

Time

The timeframe was 8 weeks, which was enough time to capture a change.

Evidence-Based Practice Framework & Change Theory

According to Melnyk & Fineout-Overholt (2019), the Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) framework guides the development and implementation of a project step by step by utilizing a conceptual model, a standardized process, and framework tools. This model is a problem-solving approach to a practice problem and assists healthcare organizations with decision-making by integrating the best available scientific evidence. The JHNEBP framework includes ten tools to support and prompt nurses through the process, which include checkbox formats, definitions, and guidelines for use. There are three phases in the framework: practice question, evidence, and translation discussed at length in their respective sections. In this project, the practice problem of poor-quality BPM was shaped into the PICOT question as noted above. In the evidence phase, a search for evidence to support improving the quality of BPM was completed. The evidence was screened for inclusion criteria and rated, or appraised using the rating scale tool, then summarized. The evidence explained the importance of a BPM protocol to ensure a standardized approach to comply with the AHA CPGs. Once the evidence phase was completed and the evidence was synthesized, recommendations emerged based on the quality of the evidence, which was the implementation of a BPM protocol. The translation pathway selection was based on the strength of the evidence. The translation phase incorporated recommendations for a BPM protocol that included the use of an approved automated, validated, and calibrated device, the patient resting quietly for five minutes before BPM, not talking before or during BPM, not eating/drinking/ smoking/exercising for at least 30 minutes before BPM, bladder emptied, seated in a chair with the back supported, and feet flat on the ground, arm supported, appropriate BP cuff size placed on the upper arm at the level of the right atrium, and document an average of at least two BPM readings in the medical record. The next steps included implementing and evaluating the BPM protocol and dissemination to the facility and USAHS, all noted below.

Kotter and Cohen's Model for Change served as the change theory for this project. Melnyk & Fineout-Overholt (2019) note first that a sense of urgency must be created to inspire the staff to change. Second, a guiding coalition in the form of stakeholders is built to guide, coordinate, and communicate the activities of the project. Third, a strategic vision is formed to get the buy-in on how the future state will look. Fourth, a volunteer army, or project team, is created to rally around the common goal. Fifth, action is enabled by removing barriers and clearing the way to make change possible. Sixth, generating short-term wins keeps the team motivated and engaged. Seventh, to sustain acceleration, no steps need to be skipped. Finally, eighth, change requires communication connections between new behaviors and organizational success until it is enforced enough times to replace bad habits. Kotter and Cohen's Model for Change fit this project well because the authors believed that individuals change when they feel differently or when change sparks an emotional response. The change agent, or project manager (PM), articulated in an emotionally engaging way, allowing staff to identify the problem, experience different feelings, and change their behavior (Melnyk & Fineout-Overholt, 2019). Articulating to the staff that there was a lack of a clear process regarding BPM resulting in poor-quality measurements, and the effects of misdiagnosis, mistreatment, and delays in care sparked an emotional response and willingness for change.

Evidence Search Strategy

A systematic electronic literature search was conducted utilizing the university databases including PubMed, ProQuest, CINAHL, Ovid, and Google Scholar. Search terms and keywords included ‘blood pressure’ “AND” ‘blood pressure measurement guideline’ “AND” ‘blood pressure measurement technique’ “AND” ‘adult’ “AND” ‘automatic OR automated’ “AND” ‘office OR clinic’. Guided indexing of keywords to abstract/title was applied. All evidence published between 2017 and 2022 met the inclusion criteria. Evidence types eligible for inclusion included quantitative, systematic reviews, meta-analyses, clinical trials, and clinical standards or practice guidelines. Articles had to meet the following inclusion criteria for consideration: published in English, published in an academic journal, and studied automated BPM techniques in adults in an office setting. Articles older than 2017, involving the pediatric population, invasive BPM techniques, or outside the office setting were excluded.

Evidence Search Results

A total of 1,751 articles were identified in the electronic databases searched. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed (Figure 1) (Moher et al., 2009). After 324 duplicates were removed, the 1,427 remaining article titles and/or abstracts were reviewed for inclusion. A total of 51 full-text articles were reviewed to determine which met all inclusion criteria, including five additional articles that were identified by reference search during the full-text review phase. A total of 31 articles were removed for not including BPM techniques (8), utilizing a manual BPM (2), studied home or ambulatory BPM methods (7), did not utilize upper arm BPM assessment (2), not published in English (1), commentary on a guideline but no recommendation (5), studied physician preference of BPM (1), studied in the pediatric population (3), or were studied outside of an office or clinic setting (2). A total of 20 articles were included.

The Johns Hopkins EBP Model Appendix D tool (Dang et al., 2022) was used to grade the strength of evidence as noted in Appendix A, Appendix B, Appendix C, and Appendix D. Evidence grade Level I included experimental studies, randomized controlled trials (RCT), and systematic reviews of RCT, with or without meta-analysis. Level II included quasi-experimental, and combination systematic reviews, with or without meta-analysis. Level IV included the opinion of respected authorities and/or nationally recognized expert committees or consensus panels based on scientific evidence (CPGs, position statements). Level V included studies based on experiential and non-research evidence (scoping reviews, integrative reviews, literature reviews, and quality improvement). The quality of the articles was assessed by utilizing the Johns Hopkins EBP Model Appendix E tool for research evidence, and Appendix F tool for non-research evidence (Dang et al., 2022). The final 20 articles were a mix of strength, but all high quality. A breakdown of the articles included four primary research articles, two rating level II and two rating level V, all rating an A in quality; two systematic reviews, level I and II, both rated A in quality; six additional reviews with one rating level I and five level V, all A quality; and nine level IV quality A CPGs. There was a good mix of research, systematic reviews, and expert clinical guidelines. Overall, the quality of the evidence was excellent, supporting the guidance in this EBP change project.

Themes with Practice Recommendations

There were many consistent themes identified in the literature that directly impact the quality of BPM. BPM was the most common and critical clinical assessment finding that is used to diagnose and treat hypertension; however, it is often done incorrectly (Boonyasai et al., 2018; Chen et al., 2018; Hwang et al., 2018; Kallioinen et al., 2017; Matheson et al., 2020; Muntner et al., 2019-b). The BPM was sensitive to multiple extrinsic and behavioral factors that include the patient, the technique of BPM, and the equipment (Matheson et al., 2020; Muntner et al., 2019-a; Muntner et al., 2019-b; Nagaraju et al., 2022; Over, 2020; Unger et al., 2020). The literature noted several barriers that led to inaccurate BPM that included 29 potential technique errors

(Kallioinen et al., 2017; Over, 2020). The recommended techniques were too time-consuming and impractical in real-world practice (Boonyasai et al., 2018; Hwang et al., 2018). There was a noted lack of knowledge by healthcare staff of the recommended guidelines (Hwang et al., 2018; Matheson et al., 2020). The major themes from the literature in Appendices A, B, C, and D are explored below.

Patient-Related Errors

The factors that influenced patient-related errors included a recent meal, caffeine, nicotine, or alcohol ingestion, a full bladder, cold exposure, and lack of rest before BPM. The literature unanimously recommended no food, caffeine, nicotine, or alcohol for at least 30 minutes before BPM. The room should be at a comfortable temperature. The patient should have an empty bladder and should rest quietly for at least five minutes before BPM (Chen et al., 2018; Department of Veterans Affairs/Department of Defense et al., 2020; Drawz et al., 2020; Hwang et al., 2018; Muntner et al., 2019-a; Muntner et al., 2019-b; Nagaraja et al., 2022; Over, 2020; Stergiou et al., 2021; Unger et al., 2020; Whelton et al., 2017).

BPM Technique Errors

The factors that influenced errors in the BPM technique included the patient's body position, arm position, BP cuff size and placement, talking during measurement, and documentation of a single reading. The literature noted that the patient should be seated in a chair with their back supported, and their feet flat on the ground. The arm should be supported on a table with the palm facing up. Appropriate cuff size should be used such that the bladder of the BP cuff encircles 75-100% of the arm and a width that is 37-50% of the arm circumference. The cuff should be placed on the upper arm about 2-3 cm above the antecubital fossa, at the level of the right atrium. The patient should rest quietly for at least five minutes before BPM with no talking before or during measurement. An average of two or more readings should be recorded (Boonyasai et al., 2018; Chen et al., 2018; Department of Veterans Affairs/Department of Defense et al., 2020; Drawz et al., 2020; Hwang et al., 2018; Kallioinen et al., 2017; Muntner et al., 2019-a; Muntner et al., 2019-b; Nagaraja et al., 2022; Ogedegbe & Pickering, 2010; Over, 2020; Robbins, 2021; Stergiou et al., 2021; Unger et al., 2020; Vischer & Burkard, 2021; Whelton et al., 2017). One study recommended taking three BPMs after a five-minute rest, discarding the first one, and taking the mean of the second and third measurements (Vischer & Burkard, 2021). One study found no significant difference between the cuff on a bare arm, which is the AHA guideline, versus the cuff over a thin shirt (Seguret et al., 2020). Another study found that a five-minute rest, which is the AHA guideline, versus a ten-minute rest before BPM was clinically observable (Tice et al., 2019).

Equipment Related Errors

Automated, or automatic, oscillometric BPM was noted to be the preferred method over manual BPM due to errors in technique or performance with manual BPM (Boonyasai et al., 2018; Chen et al., 2018; Drawz et al., 2020; Leung et al., 2017; Matheson et al., 2020; Muntner et al., 2019-a; Nagaraju et al., 2022; Ogedegbe & Pickering, 2010; Over, 2020; Whelton et al., 2017). Additional equipment-related errors included the use of unvalidated devices or devices that were not calibrated regularly. Only devices that had been validated and recommended in the literature should be used (Boonyasai et al., 2018; Chen et al., 2018; Department of Veterans Affairs/Department of Defense et al., 2020; Drawz et al., 2020; Hwang et al., 2018; Kallioinen et al., 2017; Leung et al., 2017; Muntner et al., 2019-a; Muntner et al., 2019-b; Over, 2020; Robbins, 2021; Stergiou et al., 2021; Unger et al., 2020; Whelton et al., 2017).

Impact of Errors

The level of impact of these errors varied. For example, talking during a BPM was noted to increase the systolic BPM by 4 to 19 mmHg, recent alcohol intake influenced the systolic BPM by -23.6 to +24 mmHg, a full bladder can falsely elevate systolic BPM by 4.2 to 33 mmHg, insufficient rest can falsely elevate systolic BPM by 4.2 to 11.6 mmHg, cuff size too small can falsely elevate systolic BPM by 2.1 to 11.2 mmHg and cuff size too large can underestimate systolic BPM by -3.7 to -1.5 mmHg. Overall, the significance of 27 of the 29 potential sources of error can significantly affect systolic BPM -24 to +33 mmHg and diastolic BPM -14 to +23 mmHg, which can lead to inaccurate diagnoses and treatment (Kallioinen et al., 2017; Muntner et al., 2019-a; Over, 2020).

Practice Recommendation

To overcome the many factors that contributed to the variability in BPM, the literature unanimously recommended a standardized office BPM process, or protocol, following the above criteria (American Heart Association et al., 2018; Boonyasai et al., 2018; Chen et al., 2018; Department of Veterans Affairs/Department of Defense et al., 2020; Drawz et al., 2020; Kallioinen et al., 2017; Leung et al., 2017; Matheson et al., 2020; Muntner et al., 2019-a; Muntner et al., 2019-b; Nagaraju et al., 2022; Over, 2020; Robbins, 2021; Stergiou et al., 2021; Vischer & Burkard, 2021). The standardized office BPM protocol included the use of an approved automated, validated, and calibrated device, the patient resting quietly for five minutes before BPM, no talking before or during BPM, no eating/drinking/ smoking/exercising for at least 30 minutes before BPM, bladder emptied, seated in a chair with the back supported, feet flat on the ground, arm supported at the level of the heart, appropriate BP cuff size placed on upper arm at the level of the right atrium, and documented the average of at least two BPM readings. This recommendation came from a thorough and rigorous review of nine CPGs, two systematic reviews, a randomized control trial, and several other integrative reviews. The literature was strong, the quality was high, and the recommendations were consistent that implementing a standardized BPM protocol would improve the quality of BPM.

Setting, Stakeholders, and Systems Change

The setting for this DNP scholarly project was on one floor of a primary care department in a large government healthcare facility, in Southern California. The floor included 14 patient-aligned care teams (PACT) that each consisted of a provider, a registered nurse (RN), and a licensed vocational nurse (LVN); a walk-in clinic with a provider and two RNs; a new patient clinic with a provider and LVN, and float nursing staff. The participants for this project included all primary care RNs and LVNs on the one floor, all with varying years of experience and education. The mission and vision of this medical center were to fulfill President Lincoln's promise "To care for him who shall have borne the battle, and for his widow, and his orphan" by serving and honoring the men and women who are America's Veterans (U.S. Department of Veterans Affairs, 2021). The medical center was part of a large bureaucratic integrated healthcare system with a culture rich in EBP.

The stakeholders in this pilot project included primary care leadership, primary care RNs, and LVNs who worked on the primary care floor, quality, and Biomed. The collaboration and buy-in among the stakeholders to create and implement a standardized BPM protocol, and the urgency to improve the quality of BPM was key to sustainability. Once rolled out in primary care, the protocol was rolled out to all outpatient clinical areas of the facility. Collaboration with all areas of nursing was required to improve the quality of facility-wide BPM. Sustainment was achieved through continuous observations and feedback, and the incorporation of the protocol into nursing service orientation and the annual skills fair.

A SWOT (strength/weakness/opportunity/threat) analysis was completed (Appendix E). Strengths included facility support and equipment and supplies already in place; weaknesses included workflow, time constraints, and a large number of clinics; opportunities included workflow and quality of patient care improvement; and threats included the impact on workflow, staff resistance, and lack of patient cooperation. This system's change impacted the micro level initially as it was localized to one floor of primary care, then expanded to the meso level as the project was adopted into all outpatient areas of nursing, then to the macro level when a facility standard of work was created, and when it was shared as best practice with the regional Veterans Integrated Service Network (VISN).

Implementation Plan with Timeline and Budget

There were three objectives accomplished during this implementation plan. The first was the PM, a DNP student, created a BPM protocol and training plan by week 5 of NUR7802. The second was the PM provided hands-on training to all RN and LVN staff on the primary care floor on the BPM protocol and appropriate cuff size and placement by week 11 of NUR7802. The third was an observed improvement in compliance with the BPM protocol by the end of week 13 of NUR7803.

Implementation Plan

The implementation plan, noted in Appendix F, was guided by both EBP and change theory frameworks, where it fell within the translation phase of the JHNEBP model and followed Kotter and Cohen’s Model for Change. The JHNEBP translation phase determined how the changes were made within the facility and where the action plan was made. A protocol was created by the PM (Appendix G), based on the recommendations of the evidence, and staff were trained on the protocol and appropriate cuff size selection and placement. Stakeholders provided appropriate support and resources to ensure successful implementation. The protocol was implemented as a pilot within one primary care floor. Observations on protocol adherence were made by the PM, data was gathered and evaluated in a secure SharePoint, and the outcomes were reported to the stakeholders and disseminated to both the facility and USAHS (Melnyk & Fineout-Overholt, 2019). These steps are noted in the implementation plan in Appendix F.

Melnyk & Fineout-Overholt (2019) noted the eight steps in this change theory. First, a sense of urgency was created to inspire the staff to change. Baseline compliance data of adherence to AHA CPGs was shared with the staff by week 3 of NUR7802. Second, a guiding coalition was built to guide, coordinate, and communicate the activities of the project. The final group of stakeholders, including primary care leadership, quality, unit primary care RNs and LVNs, and Biomed were identified by the end of week 5 of NUR7802. Third, a strategic vision was formed to get the buy-in on how the future state would look. The BPM protocol was created by the PM who trained the unit RN and LVN staff on the protocol and appropriate cuff size selection and placement by the end of week 5 of NUR7802. Fourth, a volunteer army was created to rally around the common goal. The project team which consisted of unit RNs and LVNs, the PM and the unit section chief was created by the end of week 5 of NUR7802. Fifth, the action was enabled by removing barriers and clearing the way to make change possible. All unit RN and LVN staff were trained in the BPM protocol, including appropriate cuff size selection and placement. Potential issues were identified and addressed by the end of week 9 of NUR7802. Sixth, generating short-term wins kept the team motivated and engaged. Weekly data was shared and celebrated with the staff on the progress of compliance with the protocol during weeks 13 of NUR7802 through week 5 of NUR7803. Seventh, to sustain acceleration, no steps needed to be skipped. Adherence to the implementation timeline ensured that no steps were skipped. And eighth, instituting change came from communicating connections between new behaviors and organizational success until they were strong enough to replace bad habits. Final data were collected and analyzed in week 3 of NUR7803. A formal standard of work was drafted by the end of week 11 in NUR7803 to solidify the process as standard practice. The PM worked with education to incorporate the BPM protocol into nursing service orientation for all new nursing staff, which included RNs, LVN, and CNAs, and into the annual skills fair to sustain the project and ensure high-quality BPM facility-wide.

The PM's role during this implementation plan was to ensure the project proceeded along the timeline toward the goal. The PM balanced the strengths of the project team members across the project to ensure the desired outcome. The PM was responsible for clearly articulating the project aim, and the stakeholder needs and wants. The PM was the planner, the communicator, and the data analyst, and possessed a balance of leading, engaging, and inspiring others toward the goal (Harris et al., 2018).

Budget

Budget considerations for this project are noted in Table 1. Personnel training, equipment, and supplies, as well as indirect costs, were noted at around $46,845.24. The total cost of this project was around $100 for printed material. The cost-effectiveness was difficult to calculate as the prevalence of HTN related to inaccurate BPM was unknown (Bhatt et al., 2017). There was a minimal cost to this project as the staff, equipment, and supplies were already in place.

Results

The results were an analysis of the outcome of the PICOT, which was an improvement in the quality of the BPM utilizing a standardized BPM protocol. To evaluate the quality of the BPM and adherence to the standardized protocol in this pilot, both pre-and post-intervention observations were made utilizing an observation tool, the AMA's BPM Skills Assessment Tool (Appendix H). Permission to use the tool was granted if there were no alterations made to the tool; no alterations to the tool were made. This observation tool was part of the AMA toolkit, and no studies noting the validity or reliability of the tool were found. This observation tool was developed against the AHA CPGs to ensure all steps were followed in obtaining a high-quality and accurate BPM. Participants for this project included all RNs and LVNs on one floor of a primary care department in a large government healthcare facility, in Southern California. No staff was excluded as participants.

The data collection reflected staff adherence to the standardized protocol. Data was collected in a yes, the protocol was followed, or a no, the protocol was not followed fashion, along with the degree to which the protocol was followed. A yes included use of an approved automated, validated, and calibrated device, the patient rested quietly for five minutes before BPM, no talking before or during BPM, no eating/alcohol/smoking/exercising for at least 30 minutes before BPM, the bladder was emptied, the patient was seated in a chair with their back supported, feet flat on the ground, the arm was supported, appropriate BP cuff size and placement on the upper arm at the level of the right atrium over the brachial artery, and at least two BPM readings were averaged and entered in the electronic record. A no resulted in the absence of any of the yes criteria. Observations were made with the AHA's BPM Skills Assessment Tool to capture compliance with the protocol, as noted in Appendix H. No patient identifiers were captured. The PM was responsible for collecting ten observations per day and entering the data into an Excel spreadsheet, housed in a secure SharePoint, who then completed the data analysis. Data integrity was reliable and consistent as the PM collected the data, removing any variation in observation. There were no HIPAA concerns with this project as no patient identifiers were collected. Missing data was not an issue as the PM was the sole data collector. There were no risks noted in this project.

The evaluation design of this pilot compared pre-intervention observation data means to post-intervention observation data means. Both process and outcome categories of measurement were nominal for the dependent variable and interval for the independent variable (Table 2). Data were analyzed through the Intellectus Statistics software (2019) utilizing the independent samples *t*-test statistical test. This project looked at the level of change in the quality of BPM with a standardized protocol, and this test was appropriate as it compared two independent means of the pre-intervention and post-intervention observations (Sylvia & Terhaar, 2018). The results of this test were significant based on an alpha of .05 and *p*-value <.001 (Appendix J1). However, the assumption of normality was violated, and the Mann-Whitney Test was run (Intellectus Statistical software, 2019). Statistical significance was achieved at an alpha value of .05 and *p*-value < 0.001, which indicated that the results of the intervention were not found by chance, and the null hypothesis was rejected (Appendix J2). The findings suggested a statistically significant level of change between pre-and post-intervention means, with pre-intervention compliance of AHA CPG at 5.00 techniques, compared to the post-intervention mean of 9.00 techniques.

Clinical significance was achieved with an improvement in quality BPM as evidenced by increased adherence to the standardized protocol from a mean of 5 techniques to a mean of 9 out of a possible 14. In addition, the number of primary care patients with HTN decreased from 37% to 33%, and the number of patients with normal blood pressure increased from 63% to

67%, ultimately improving the HTN metric from 66% to 71% during this project (Electronic Quality Measurement, 2023).

This project complied with the approval process for implementation of an EBP system-change project and was approved by both USAHS and the facility. The proposal for the DNP scholarly project was implemented following approval from the EBP Project Review Council (EPRC) at USAHS and by obtaining all required approvals from the facility where the project was implemented.

Impact

This project addressed the practice problem of poor quality and inaccurate BPM by getting back to the basics. Staff were trained on a BPM protocol that was created from the CPGs for BPM. This was not an easy task, as staff were consistently faced with barriers to the protocol. Staff had to slow down their workflow to ensure the protocol was followed, and patients had to be re-educated to allow staff to obtain the BPM according to protocol.

Both statistical and clinical significance were achieved, the most important being the clinical significance. This represented the change in staff behavior in obtaining a BPM. They improved from a mean of meeting 5 to meeting 9 of the possible 14 required techniques in a high-quality BPM per the CPGs. In addition, the number of primary care patients with HTN decreased, and the number of patients with normal blood pressure increased, ultimately improving the primary care HTN metric during this project. While improvements were made, continued reminders of practice change were essential to prevent staff from resorting back to their old habits. The PM continued to make observations and provide re-training after project completion to ensure sustainability.

Concerns with the sustainability of the project were the time constraints the staff were under to maintain throughput. Patients were scheduled for 30-minute appointments, and the nursing staff had about 15 to 20 minutes of pre-appointment tasks to complete before the patient saw the provider. This was not an issue if the patient complied with coming 30 minutes early. When patients arrived on time or late, the nursing staff were rushed and did not follow the BPM protocol. As all PACT teams had their panel sizes increased by 5% during this pilot, time constraints could have impacted compliance with the BPM protocol. This temporary increase in panel size has future implications as well. The culture around the importance of an accurate BPM needs to be changed. This pilot planted the seed of change within this primary care unit to allow this change to grow. This pilot was expanded to all primary care and outpatient clinics and implemented into nursing service orientation and annual skills fair.

Maintaining success required cooperation and engagement from all nursing staff, the PACT coordinator, and managers within primary care and outpatient clinics, and the education department. Staff hold each other accountable with weekly audits of one staff member, and data continues to be shared at the monthly staff meetings until staff hit 14 out of 14 required techniques. The HTN metric was evaluated monthly and shared with staff. Primary care leadership was responsible for sustainment and measuring success through practice observations and the HTN metric monitoring.

Barriers to the project included the increase of all PACT team panel sizes by 5% during this pilot, time constraints of busy clinics, space to allow patients to rest quietly for 5 minutes before BPM, patient compliance with the protocol, and staff resistance to change.

Dissemination

Initially, this project was disseminated to the stakeholders and USAHS faculty, then to the facility, through mechanisms noted below. The results of the project were shared with all stakeholders via a PowerPoint presentation, and with USAHS faculty through an oral poster presentation. It was then shared with all primary care and outpatient clinics and with nursing education for incorporation into nursing service orientation. The protocol was incorporated into the annual skills fair, and into a standard of work to ensure sustainment with high-quality BPM facility-wide. This project was published to the Scholarship and Open Access Repository

(SOAR) for archiving, where there is an opportunity for peer review and feedback before any submission for publication.

Future planned opportunities to disseminate include presentations at the Nurse Practice Committee, the Evidence-Based Practice Committee, and the 2024 Nurses Week poster presentation. A brief PowerPoint presentation will be scheduled at the virtual, all-employee weekly Journey to Excellence meeting. The results will be further disseminated at the regional VISN primary care level through a presentation on the High-Reliability Organization's principle, reluctance to simplify. Future publication in the *Journal of Primary Care & Community Health* could be an appropriate option as primary care clinics face many of the same challenges.

Conclusion

The purpose of this EBP project was to improve the quality of BPM. The significance of low-quality BPM and its impact on the patient, healthcare, and society was explored. Both the Johns Hopkins Evidence-Based Practice framework and Kotter and Cohen's Model for Change were used to guide this project. The evidence unanimously recommended the use of a standardized BPM protocol to ensure quality BPM. A realistic implementation plan was proposed that included the creation of a standardized BPM protocol, training of staff, and observations of compliance utilizing the AMA's BPM Skills Assessment Tool, an observation tool. A data analysis plan with an evaluation of both statistical and clinical significance was developed. Finally, a dissemination plan of the results to the facility, the faculty, and possible publication opportunities was provided. The success of this project resulted in a facility-wide standardized process with sustainment, ensuring quality BPM is taken at every point of care.

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Table 1

Implementation of EBP Project Budget

Personnel Training	Number Needed	Total Hours	Salary	Fringe Benefits (28%)	Total Salary	Total Cost in Dollars	Funding Source
SOW Training	17 RNs 16 LVNs	1hr	50/hour 30/hour	14/hour 8.4/hour	64/hour 38.4/hour	850.00/1 hour 614.40/1 hour	In-Kind
SUBTOTAL COST						**1,464.40**	

Equipment	Number Needed	Cost per Unit	Total Cost in Dollars	Funding Source
Computer	16	1,200.00	19,200.00	In-Kind
Portable BP Machine	16	1050.00	16,800.00	In-Kind
Reusable BP cuffs	360	25.00	9,000.00	In-Kind
SUBTOTAL COST			**45,000.00**	

Supplies	Number Needed	Cost per Unit	Total Cost in Dollars	Funding Source
Paper	2 reams	5.34	10.68	In-Kind
Printer Ink	1 per color	100.00	100.00	In-Kind
Conference Room	4 hours			In-Kind
Electricity- Conference Room	4 hours	0.42/kWh	1.68	In-Kind
Electricity- BP machines	320 hours	0.42/kWh	134.40	In-Kind
Electricity- Computers	320 hours	0.42/kWh	134.40	In-Kind
SUBTOTAL COST			**380.84**	

TOTAL COST	**46,845.24**
REVENUE	Unknown
TOTAL REVENUE	Unknown
NET BALANCE	-46,845.24

Note: All budget entries are estimates. Expenses are based on means. Revenue estimates do not include potential cost avoidance due to realized outcomes. All costs associated with salary and benefits, patient care supplies, and overhead are fixed indirect expenses not associated with this project. Project costs are nominal for printing, around $100.

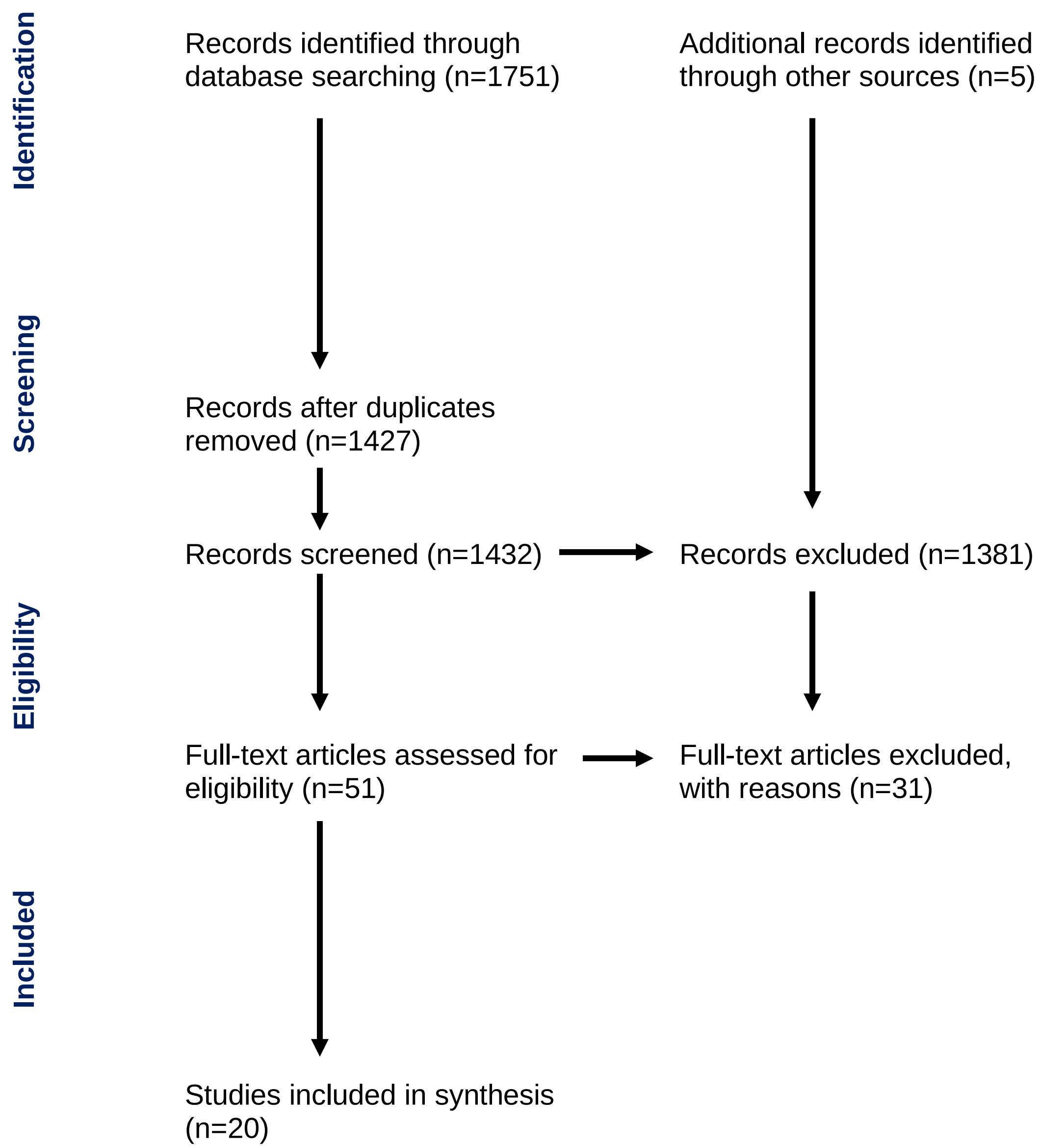
Table 2

Descriptive Variable Information

	Variable Name	Variable Description	Data Source	Possible Range of Values	Level of Measurement	Time Frame for Collection
	Observation of BPM	Pre-implementation observation	Observations of AHA CPG Adherence	Yes No	Nominal	Pre-intervention observation 2 weeks before implementation
	Observation of BPM	Pre-implementation observation	Degree of AHA CPG Adherence	0-14	Interval	Pre-intervention observation 2 weeks before implementation
	Standardized BPM Protocol	Implementation of BPM protocol	Observations of AHA CPG Adherence	Yes No	Nominal	Post-intervention observation Weeks 1-8
	Standardized BPM Protocol	Implementation of BPM protocol	Degree of AHA CPG Adherence	0-14	Interval	Post-intervention observation Weeks 1-8
	Improved quality of BPM	Number of patients with quality BPM	Mean of observations	0-14	Interval	Pre- and post-intervention observation mean. End of week 8

Figure 1

PRISMA Flowchart



Note. Prisma flow

chart diagram from "Preferred Reporting Items for Systematic Reviews and Meta-analyses: The PRISMA Statement," by D. Moher, A. Liberati, J. Tetzlaff, & D.G. Altman, 2009, Annals of Internal Medicine, 151(4), p.267 (http://dx.doi.org/10.7326/0003-4819-151-4-200908180-00135).

Appendix A

Summary of Primary Research Evidence

Citation	**Design, Level** **Quality Grade**	**Sample** **Sample size**	**Intervention** **Comparison**	**Theoretical Foundation**	**Outcome Definition**	**Usefulness Results Key Findings**
Boonyasai, R. T., Carson, K. A., Marsteller, J. A., Dietz, K. B., Noronha, G. J., Prokopowicz, G. P., Miller, E. R., & Cooper, L A. (2018). A bundled quality improvement program to standardize clinical blood pressure measurement in primary care. *Journal of Clinical Hypertension, 20*, 324-333. http://doi.org/10.1111/jch.13166	Quasi-Experimental IIA	Primary Care Clinic Nursing Staff N=100	Intervention: Implementation of a standardized BPM bundle Comparison: Usual BPM	Not stated.	Improvement in device and guideline adherence	Yes. Creation of standardized BPM protocol
Hwang, K. O., Aigbe, A., Ju, H. H., Jackson, V. C., & Sedlock, E. W. (2018). Barriers to accurate blood pressure measurement in the medical office. *Journal of Primary Care & Community Health, 9*, 1-7. https://doi.org/10.1177/2150132718816929	Qualitative QI, VA	Adult Primary Care Clinic Nursing Staff N=18	Intervention: Field observations, interviews, focus groups Comparison: Usual BPM	An inductive approach to thematic analysis	Staff knowledge and behavior; workflow constraints; equipment issues; patient characteristics and behavior	Yes. Barriers identified in applying guidelines into practice, and possible solutions.
Matheson, E., Kremer, M., Fogg, L., & Crisanti, G. (2020). Ensuring accurate BP measurements. *Nursing2020, 50*(4), 63-69. https://doi.org/10.1097/01.NURSE.0000657040.45768.02	QI VA	Cardiac Intensive Care Unit Nursing Staff N=110	Intervention: Educational session with pre-and post-test of AHA guidelines; poster reminders; BP cuffs in multiple sizes were stocked;	Not stated.	Improvement from 5.2/10 to 8.54/10 AHA guidelines during BPM	Yes. Re-education on AHA guidelines, reminder posters, and ensuring adequate supplies and functioning

			equipment fixed Comparison: usual BPM			equipment improved guideline compliance.
Tice, J. R., Cole, L. G., Ungvary, S. M., George, S. D., & Oliver, J. S. (2018). Clinician accountability in a primary care clinic time-interval blood pressure measurements study: Practice implications *Applied Nursing Research, 45,* 69-72. https://doi.org/10.1016/j.apnr.2018.12.006	Repeated Measures IIA	Adult Primary Care Clinic N=100	Intervention: BPM at baseline, at 5 minutes, and 10 minutes Comparison: Usual practice	Not stated.	2 within-subjects ANOVAs were run on SBP at baseline, 5min, and 10min. There was statistical significance p<.001 for SBP at 5 min	Yes. Confirms AHAs recommendation of 5-minute rest before BPM.

Legend: BP- Blood Pressure; BPM- Blood Pressure Measurement

Appendix B

Summary of Systematic Reviews

Citation	**Quality Grade**	**Question**	**Search Strategy**	**Inclusion/ Exclusion Criteria**	**Data Extraction and Analysis**	**Key Findings**	**Usefulness/ Recommendation/ Implications**
Kallioinen, N., Hill, A., Horswill, M. S., Ward, H. E., & Watson, M. O. (2017). Sources of inaccuracy in the measurement of adult patients' resting blood pressure in clinical settings: A systematic review. *Journal of Hypertension, 35*(3), 421-441. https://doi.org/10.1097/HJH.0000000000001197	IIA	Sources of inaccuracy in the adult patient's resting BPM in a clinic setting	A search for each identified inaccuracy using Medline and CINAHL.	Inclusion: Journal articles, from the inception of the database to 2015, in English, relating to humans. Exclusion: Home BPM, 24-hour ambulatory BPM, locations other than the upper arm	Title/abstract reviewed, the full text of potentially relevant articles reviewed. Extracted data that met inclusion varied regarding the source of inaccuracy. The process by 1 reviewer, was reviewed by another.	29 potential sources of inaccuracy were identified and categorized into one of 4 areas: patient-related, device-related, procedure-related, and observer-related.	Yes. Provides the rationale behind clinical practice guideline recommendations. Recommends standardized protocol for office BPM.
Nagaraju, S. P., Shenoy, S. V., Rao, I. R., Bhojaraja, M. V., Rangaswamy, D., & Prabhu, R. A. (2022). Measurement of blood pressure in chronic kidney disease: Time to change our clinical practice- A comprehensive review. *International Journal of Nephrology and Renovascular Disease, 15*, 1-16. https://doi.org/10.2147/IJNRD.S343582	VA	BP in CKD: Time to change our clinical practice?	Review of 3 clinical practice guidelines	Clinical practice guidelines that address BPM.	3 clinical practice guidelines compared	All 3 clinical practice guidelines recommended standardized office BPM	Yes. Recommends standardized protocol for office BPM.

Citation	**Quality Grade**	**Question**	**Search Strategy**	**Inclusion/ Exclusion Criteria**	**Data Extraction and Analysis**	**Key Findings**	**Usefulness/ Recommendation/ Implications**
Seguret, D., Gamelon, D., Dourmap, C., & Steichen, O. (2020). Blood pressure measurements on a bare arm, over a sleeve or below a rolled-up sleeve: A systematic review and meta-analysis. *Journal of Hypertension, 38*(9), 1650-1659. https://doi.org/10.1097/HJH.0000000000002460	IA	Effect of the sleeve on BPM	PubMed and EMBASE	Inclusion: cross-sectional studies comparing BPM on bare, sleeved, or below rolled-up sleeve; inception to February 5, 2020;	2 reviewers extracted the data; meta-analysis comparing mean differences using a study-level random effects model.	Insignificant 0.59mmHg overestimation in SPB measured over thin sleeve; 1.10mmHg over thick sleeve and 2.76 mmHg with the sleeve rolled up above the cuff	Yes. No significant difference in BPM over the thin sleeve.

Legend: AHA- American Heart Association; BP- Blood Pressure; BPM- Blood Pressure Measurement; CKD- Chronic Kidney Disease

Appendix C

Summary of Other Reviews

Citation	Quality Grade	Question	Search Strategy	Inclusion/ Exclusion Criteria	Data Extraction and Analysis	Key Findings	Usefulness/ Recommendation/ Implications
Chen, Y., Lei, L., &Wang, J. G. (2018). Methods of blood pressure assessment used in milestone hypertension trials. *Pulse, 6*, 112-123. https://doi.org/10.1159/000489855	IA	Methods of BPM	Outcome trials in PubMed	RCTs with blinded or open design, English, January 1, 1990- April 1, 2017, Exclusion: Surrogate outcome, CHF, ESRD, acute stroke	36 milestone HTN trials.	Evaluated 9 aspects of BPM: observer, device, measurements, the time between BPM, resting period, position, arm, cuff, drug timing	Yes. Recommends standardized protocol for office BPM following current guidelines
Drawz, P. E., Beddhu, S., Kramer, H. J., Rakotz, M., Rocco, M. V., & Whelton, P. K. (2020). Blood pressure measurement: A KDOQI perspective. *American Journal of Kidney Disease, 75(*3), 426-434. https://doi.org/10.1053/j.ajkd.2019.08.030	VA	BPM: A KDOQI Perspective	Review of new AHA guidelines, referencing 3 other guidelines	BPM guidelines	Proper patient preparation and device use	Enforcement of guideline recommendations	Yes. Recommends standardized protocol for office BPM to ensure guideline adherence
Ogedegbe, G. & Pickering, T. (2010). Principles and techniques of blood pressure management. *Cardiology Clinics, 20*(2), 571-586. https://doi.org/10.1016/j.ccl.2010.07.006	VA	Principles and Techniques of BPM	Not stated. References reviewed and include practice guidelines.	Technical issues with BPM from the upper arm	Effect of posture, body position, cuff inflation, cuff size, devices	Findings support AHA guidelines	Yes. Findings support AHA guidelines

Citation	Quality Grade	Question	Search Strategy	Inclusion/ Exclusion Criteria	Data Extraction and Analysis	Key Findings	Usefulness/ Recommendation/ Implications
Over, D. R. (2020). Avoiding missteps in BP measurement. *The Journal of Family Practice, 69*(2), E1-E5.	VA	Avoiding missteps in BPM	Review of clinical practice guidelines and SRs	N/A	SR identified sources for error in BPM	Adherence to standardized BPM protocol helps control the factors of BPM error	Yes. Recommends standardized protocol for office BPM
Vischer, A. S. & Burkard, T. (2021). How should we measure and deal with office blood pressure in 2021? *Diagnostics, 11*, 235-247. https://doi.org/10.3390/diagnostics11020235	VA	How Should We Measure and Deal with Office BP in 2021?	Review of 6 major guidelines	Clinical practice guidelines that address BPM	Pulled out areas the guidelines disagreed	Resting period before BPM; the number of measurements, which measurements for the calculated value	Yes. Recommends standardized protocol for office BPM. Clarified disagreements: 5 min resting before BPM and mean of 2nd and 3rd BPM

Legend: AHA- American Heart Association; BP- Blood Pressure; BPM- Blood Pressure Measurement; CKD- Chronic Kidney Disease

Appendix D

Summary of Clinical Practice Guidelines and Scientific Statements

Citation	Level Quality	Clinical Question	Recommendation
American Heart Association, British Hypertension Society, Chinese Regional Office of the World Hypertension League, Hypertension Canada, International Council of Cardiovascular Prevention and Rehabilitation, International Society of Hypertension, International Society of Nephrology, Pan American Health Organization/World Health Organization Technical Advisory Group on Cardiovascular Disease, World Hypertension League, & World Stroke Organization. (2018). Recommended standards for assessing blood pressure in human research where blood pressure or hypertension is a major focus. *Clinical and Experimental Hypertension, 40*(6), 50-513. https://doi.org/10.1080/10641963.2017.1281939	IVA	Recommended standards in BPM	A standardized protocol for office BPM.
Department of Veterans Affairs, Department of Defense. (2020). *VA/DoD clinical practice guideline for the diagnosis and management of hypertension in the primary care setting.* Diagnosis and Management of Hypertension (HTN) in Primary Care (2020) - VA/DoD Clinical Practice Guidelines	IVA	Recommendations for accurate BPM in the primary care setting.	A standardized protocol for office BPM.
Leung, A. A., Dashalopoulou, S.S., Dasgupta, K., McBrien, K., Butalia, S., Zarnke, K. B., Nerenberg, K., Harris, K. C., Nakhla, M., Cloutier, L., Gelfer, M., Lamarre-Cliché, M., Milot, A., Bolli, P., Tremblay, G., McLean, D., Tobe, S. W., Ruzicka, M., Burns, K. D., …Fournier, A. (2017). Guidelines: Hypertension Canada's 2017 guidelines for diagnosis, risk assessment, prevention, and treatment of hypertension in adults. *Canadian Journal of Cardiology, 33,* 557-576. http://doi.org/10.1016/j.cjca.2017.03.005	IVA	Recommendations for accurate measurement of BP in the office	A standardized protocol for office BPM Upper arm device over manual measurement
Muntner, P., Einhorn, P. T., Cushman, W. C., Whelton, P. K., Bello, N. A., Drawz, P. E., Green, B. B., Jones, D. W., Juraschek, S. P., Margolis, K. L., Miller, E. R., Navar, A. M., Ostchega, Y., Rakotz, M. K., Rosner, B., Schwartz, J. E., Shimbo, D., Stergiou, G. S., Townsend, R. R., … Appel, L. J. (2019-a). Blood pressure assessment in adults in clinical practice and clinic-based research: JACC scientific expert panel. *Journal of American*	IVA	How the quality of BPM obtained in routine clinical practice can be improved to provide better patient care	A standardized protocol for office BPM Seated in a chair with back supported and feet flat on the floor Quietly resting for 5 min No eating, caffeine, exercise, or smoking for at least 30min before BPM Empty bladder

Colleges of Cardiology, 73(3), 317-335. https://doi.org/10.1016/j.jacc.2018.10.069			No talking before or during BPM Bare arm under the cuff Validated and calibrated device Obtain mid-arm circumference and record Supported arm Position the middle of the cuff on the upper arm at the level of the right atrium (midpoint of the sternum) Appropriate cuff size, bladder encircles 75-100% of the arm and a width that is 37-50% of the arm circumference BPM in both arms initially, then use the arm with the highest BPM Repeats in 1-2min Position the center of the cuff over the upper arm brachial artery at least 1 inch above the crease of the elbow Average of at least 2 or more BPM Note the time of the most recent BP med
Muntner, P., Shimbo, D., Carey, R. M., Charleston, J. B., Gaillard, T., Misra, S., Myers, M. G., Ogedegbe, G., Schwartz, J. E., Townsend, R. R., Urbina, E. M., Viera, A. J., White, W. B., & Wright, J. T. (2019-b). Measurement of blood pressure in humans: A scientific statement from the American Heart Association. *Hypertension, 73*, e35-66. https://doi.org/10.1161/HYP.0000000000000087	IVA	Updated AHA scientific statement on BP measurements in humans	A standardized protocol for office BPM Quiet room, comfortable temperature Seated in a chair with back supported and feet flat on the floor No moving/talking 3-5min before BPM No caffeine, exercise, or smoking at least 30min prior Empty bladder No talking before or during BPM Bare arm under the cuff Validated and calibrated device Arm supported Middle of cuff positioned on upper arm at right atrium level Appropriate cuff size, bladder encircles 75-100% of arm BPM in both arms initially, then use the arm with the highest BPM Repeats at 1-2 min

			Average 2 or more BPM Note the time of most recent BP medication
Robbins, K. C. (2021). KDIGO clinical practice guideline: Blood pressure management for patients with chronic kidney disease. *Nephrology Nursing Journal, 48*(2), 183-185. https://doi.org/10.37526/1526-744X.2021.48.2.183	IVA	Blood pressure management for patients with chronic kidney disease	A standardized protocol for office BPM Seated in a chair with back supported and feet flat on the floor Quiet for 5min before BPM Appropriate size Supported upper arm Validated and calibrated device BPM in both arms initially, then use the arm with the highest BPM
Stergiou, G. S., Palatini, P., Parati, G., O'Brien, E., Januszewicz, A., Lurbe, E., Persu, A., Mancia, G., & Kreutz, R. (2021). 2021 European Society of Hypertension practice guidelines for office and out-of-office blood pressure measurement. *Journal of Hypertension, 39*, 1293-1302. https://doi.org/10.1097/HJH.0000000000002843	IVA	Guidelines for office blood pressure measurement	A standardized protocol for office BPM No smoking, caffeine, food, or exercise 30min before BPM Quiet room, comfortable temperature 3-5min rest before BPM No talking during/between BPM Seated in a chair with back supported and feet flat on the floor Cuff to fit arm size Bare arm supported and at mid-heart level Validated ad calibrated device 3 measurements (unless the first 2 are normal). Average the last 2 readings
Unger, T., Borghi, C., Charchar, F., Khan, N. A., Poulter, N. R., Prabhakaran, D., Ramirez, A., Schlaich, M., Stergiou, G. S., Tomaszewski, M., Wainford, R. D., Williams, B., & Schutte, A. E. (2020). 2020 International Society of Hypertension global hypertension practice guidelines. *Hypertension, 75*, 1334-1357. https://doi.org/10.1161/HYPERTENSIONAHA.120.15026	IVA	Guidelines for office blood pressure measurement	Quiet room, comfortable temperature No smoking, caffeine, or exercise 30min before BPM No talking before or during BPM Seated in a chair with back supported and feet flat on the floor, bare arm resting on a table, mid-arm at heart level Validated and calibrated device Appropriate size cuff Take 3 measurements 1min between. Average the last 2 readings
Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Himmelfarb, C. D., DePalma, S. M., Gidding, S.,	IVA	Recommendations for accurate	Relax for > 5 minutes

Jamerson, K. A., Jones, D. W., MacLaughlin, E. J., Muntner, P., Ovbiagele, B., Smith, S. C., Spencer, C. C., Stafford, R. S., Taler, S. J., Thomas, R. J., Williams, K. A., … Wright, J. T. (2018). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/SCNA Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults. *Journal of the American College of Cardiology, 71*(19), e127-248. https://doi.org/10.1016/j.jacc.2017.11.006		measurement of BP in the office	Seated in a chair with back supported and feet flat on the floor. No caffeine, exercise, or smoking at least 30 min before BPM Empty bladder No talking during rest or BPM Bare arm under the cuff Validated and calibrated device Supported arm Middle of the cuff on the upper arm at the level of the right atrium Appropriate cuff size, bladder encircles 80% of the arm BPM in both arms initially, then use the arm with the highest BPM Repeats every 1-2 min Use an average of 2 or more readings Note the time of most recent BP medication

Appendix E

SWOT Analysis

Strengths	• Leadership support • Equipment and supplies already in place • Medical Media support for visuals
Weakness	• Workflow/ time constraints • Busy clinic • 14 clinics, walk-in clinic, new patient clinic
Opportunities	• Workflow improvement • Quality of patient care improvement
Threats	• Impact to workflow • Staff resistance • Lack of patient cooperation

Appendix F

Project Schedule

	NUR 7801								NUR 7802								NUR 7803							
Task	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15	Week 1	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13	Week 15
Meet with preceptor	x	X	X	x	x	X	x	X	X	X	X	X	x	x	X	X	X	X	x	x	X	x	x	x
Create project proposal		X	X	x	x	X	x	X																
Obtain baseline data							x	x	X															
Share baseline data with staff										X														
Meet with stakeholders		X									X	X	x	x	X	X	X	X	x					
Create project team											X													
Create protocol									X	X	X													
Train primary care staff on protocol, re-train if needed												X	x	x	x	x	x	x						
Go live- Implement project															X	X	X	X						
Round/observe in primary care clinics															X	X	X	X						
Data collection and analysis/feedback															X	X	X	X	x	x				
Report out to primary care/Org. Leadership																					X			
Creation of standard operating procedure (possibly after course completion)																						x		
Disseminate- After end of the course: Nursing Service Orientation, Annual Skills Fair, NPC, Nurses Week Poster, publication																								x

Appendix G

Blood Pressure Measurement Protocol

Blood Pressure Measurement- Do it Right

PREPARATION

- Ask: Have you exercised, had caffeine, smoked, or eaten within the last 30 minutes?
- Ask: Do you need to empty your bladder?
- Use a validated and calibrated device

POSITION

- Seated
- Feet flat on the floor
- Back supported
- Arm supported
- Proper-sized cuff (bladder encircles 75-100% of arm)
- Appropriate cuff placement (2cm above the antecubital fossa)
- Cuff placed on upper arm at the level of the right atrium
- Cuff placed on bare arm, or over thin sleeve
- Sat quietly for 5 minutes prior to blood pressure measurement
- No talking during blood pressure measurement

Documentation

- Take 3 blood pressure measurements, 1 minute apart
- Discard the first reading and average the remaining 2
    - AHA BP Average Calculator https://www.ama-assn.org/node/27271
- Document the average in CPRS

Appendix H

Data Collection Tool

BP measurement skills assessment

AMA | MAP BP™

Excellent blood pressure (BP) measurement technique requires training and skills, but a few common problems related to patient preparation and positioning often account for unreliable BP measurements.[1] Use this tool to verify everyone in your practice or health center obtains BP measurements the right way every time. This tool is not designed to assess individual competence. Instead, it will help detect systemic issues that may be resulting in the routine use of improper technique.

INSTRUCTIONS: Complete four observations for each team member (e.g., medical assistant, nursing staff and physicians) who regularly takes BP measurements. Repeat quarterly, monthly or as needed.

Site name: ____________________ Date: ____________________

Team member measuring BP name(s): ____________________ Observation location (clinic, unit, etc.): ____________________

Team member auditing BP measurement name(s): ____________________

	Patient No. 1			Patient No. 2			Patient No. 3			Patient No. 4		
BP measurement device used	Yes	No	Comments	Yes	No	Comments	Yes	No	Comments	Yes	No	Comments
Manual device	☐	☐		☐	☐		☐	☐		☐	☐	
Automated devices	☐	☐		☐	☐		☐	☐		☐	☐	
Patient preparation and positioning	Yes	No	If no, why not?	Yes	No	If no, why not?	Yes	No	If no, why not?	Yes	No	If no, why not?
Asked patient if bladder is full, and if yes, instructed to use the bathroom.	☐	☐		☐	☐		☐	☐		☐	☐	
Patient rested for 3-5 minutes prior to taking initial BP measurement	☐	☐		☐	☐		☐	☐		☐	☐	
Assessed for recent exercise, tobacco, caffeine or stimulant use and documented in EHR	☐	☐		☐	☐		☐	☐		☐	☐	
Seated with back supported	☐	☐		☐	☐		☐	☐		☐	☐	
Feet flat on floor or supported on a firm surface	☐	☐		☐	☐		☐	☐		☐	☐	
Legs uncrossed	☐	☐		☐	☐		☐	☐		☐	☐	
Appropriate cuff size used	☐	☐		☐	☐		☐	☐		☐	☐	
Cuff placed over bare upper arm	☐	☐		☐	☐		☐	☐		☐	☐	
Arm supported with middle of cuff at heart level	☐	☐		☐	☐		☐	☐		☐	☐	
No one talked during measurement	☐	☐		☐	☐		☐	☐		☐	☐	
Initial BP documented in EHR vitals field	☐	☐		☐	☐		☐	☐		☐	☐	
Confirmatory BP: If the initial BP was high, confirmatory BP measurement(s) should be performed and documented in the patient's EHR.	Yes	No	If no, why not?	Yes	No	If no, why not?	Yes	No	If no, why not?	Yes	No	If no, why not?
Two or three confirmatory BP measurements were performed	☐	☐		☐	☐		☐	☐		☐	☐	
Patient rested quietly for 1-2 minutes between each repeat measurement	☐	☐		☐	☐		☐	☐		☐	☐	
All repeat BP measurements were averaged (one average systolic and one average diastolic) and documented in the EHR	☐	☐		☐	☐		☐	☐		☐	☐	

This resource is part of AMA MAP BP™, a quality improvement program. Using a single or subset of AMA MAP BP tools or resources does not constitute implementing this program. AMA MAP BP includes guidance from AMA hypertension experts and has been shown to improve BP control rates by 10 percentage points and sustain results.

This skills assessment was adapted with permission of the American Medical Association and The Johns Hopkins University. The original copyrighted content can be found at https://www.ama-assn.org/delivering-care/hypertension/ama-johns-hopkins-blood-pressure-control-resources.

1. Muntner P, Shimbo D, Carey RM, et al. Measurement of Blood Pressure in Humans: A Scientific Statement From the American Heart Association. *Hypertension*. 2019;73(5). doi:10.1161/hyp.0000000000000087.

Appendix I

BPM Protocol Adherence Pre- and Post-Intervention

	Monday	Tuesday	Wednesday	Thursday	Friday
Pre-Week 1	5 6 5 5 6 7 5 5 4 5	5 5 5 6 5 5 5 6 7 6	5 5 6 5 5 5 6 5 6 6	5 5 4 5 5 5 6 5 6 6	5 5 6 6 6 5 6 5 5 5
Pre-Week 2	5 5 6 6 6 5 6 6 5 5	5 5 7 5 6 5 5 6 6 6	5 6 5 6 6 5 5 5 5 6	5 5 6 6 6 6 5 5 5 7	5 5 6 6 7 5 5 5 6 5
Post-Week 1	5 5 5 6 6 6 6 7 6 5	6 7 6 6 6 6 6 6 7 6	5 5 6 6 6 6 6 6 6 7	6 6 7 7 7 7 7 6 7 7	7 7 6 7 7 7 6 6 7 6
Post-Week 2	7 7 7 8 8 8 8 8 7 7	8 8 7 7 8 7 7 8 7 8	9 8 8 7 7 9 7 8 7 8	8 7 6 7 8 8 8 9 7 8	9 9 7 6 8 8 7 8 7 8
Post-Week 3	8 9 9 9 8 9 10 8 9 8	9 8 8 9 8 9 8 10 7 9	9 8 8 10 8 8 8 9 10 9	8 9 9 9 8 7 8 8 7 8	9 9 9 8 9 8 8 9 6 7
Post-Week 4	10 9 10 10 9 10 8 10 9 7	10 9 9 9 8 10 9 9 10 10	9 10 10 10 9 9 9 10 9 9	10 10 10 9 10 9 10 10 8 8	9 8 10 9 10 8 8 7 9 9
Post-Week 5	9 10 10 8 10 10 10 9 9 10	9 9 8 9 10 10 9 8 9 9	9 9 9 10 9 9 10 10 8 8	9 8 10 8 9 10 10 10 9 9	9 9 10 10 10 10 9 9 9 9
Post-Week 6	10 9 10 10 9 12 12 10 10 10	10 9 9 10 10 12 10 12 9 10	8 10 10 9 10 10 10 12 9 9	10 8 10 10 9 9 9 12 8 10	10 10 9 9 9 9 10 10 10 10
Post-Week 7	9 10 10 10 12 10 10 12 12 10	10 10 12 10 10 12 10 10 10 10	12 10 12 10 10 9 10 10 10 12	12 10 9 12 10 10 9 10 12 12	10 12 14 9 8 12 12 10 10 10
Post-Week 8	10 10 10 12 10 10 10 12 8 8	9 10 9 10 10 9 8 10 9 10	10 12 9 9 10 10 12 8 10 8	9 9 12 10 12 12 10 10 10 10	9 8 9 10 10 12 9 10 9 10

Appendix J

T-Test Results

Table J1

Two-Tailed Independent Samples t-Test for X_of_CPG_Followed by Obs

Variable	pre			post					
	M	*SD*	*n*	*M*	*SD*	*n*	*t*	*p*	*d*
X_of_CPG_Followed	6.04	6.06	101	8.87	1.59	400	-8.29	< .001	0.64

Note. N = 501. Degrees of Freedom for the *t*-statistic = 499. *d* represents Cohen's *d*.

Table J2

Two-Tailed Mann-Whitney Test for X_of_CPG_Followed by Obs

Variable	pre		post				
	Mean Rank	*n*	Mean Rank	*n*	*U*	*z*	*p*
X_of_CPG_Followed	66.99	101	297.46	400	1,614.50	-14.52	< .001