Improving Accuracy of Home Blood Pressure Monitoring (HBPM) in Patients

Receiving Telehealth Services

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NURG 8302 Managing Quality Initiative Through Nursing Quality Initiatives

Summer, 2021

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Abstract

Hypertension (HTN) is one of the most commonly managed problems in primary care. Home blood pressure monitoring (HBPM) is used for the diagnosis, treatment, and management of HTN in the outpatient setting. This paper describes the technological, patient, and clinician issues that contribute to inaccurate blood pressure (BP) measurements that can lead to practitioners and providers making unsound clinical decisions. This paper further discusses two specific problems that were identified during follow up visits with patients who have a history of HTN, and are being monitored via telehealth at Penn Medicine Home Health (PMHH) healthcare agency. As a result of these two problems, a question is formulated to develop a quality improvement (QI) project that seeks minimalize variability in BP measurements through sphygmomanometer validation and calibration, and standardization of the American Heart Association's (AHA) guideline-based BP measurement techniques among patient and clinicians. Outcome measures of this initiative are discussed, as well as key stakeholders.

Keywords: blood pressure, accuracy, telehealth, calibration, sphygmomanometer, validation

IMPROVING ACCURACY OF HOME BLOOD PRESSURE MONITORING

Hypertension is a global health issue that contributes to chronic diseases such as stroke, cardiovascular disease, and kidney disease. Nearly 45% of adults in the United States have HTN and in 2018, nearly half a million deaths in the United States included HTN as a primary cause or contributing cause (Centers for Disease Control and Prevention [CDC], 2020). In addition to the health burden caused by HTN, there is also a substantial economic burden. The CDC (2020) reports that high BP costs the United States $131 billion each year, on average, over 12 years from 2003 to 2014. Efficient and effective diagnosis, treatment and management of HTN is imperative to decrease mortality and morbidity, improve patient outcomes, and reduce costs.

The National Institute for Health and Care Excellence (NICE) recommends that HTN diagnosis is based on out-of-office measurements, given the risk of white-coat HTN, which is defined as a difference of greater than 20/10 mmHg, between office readings and average day-time home or ambulatory measurements (Jones et al., 2010). Ambulatory blood pressure monitoring (ABPM) is the gold standard and has been found to be a better predictor of target end-organ damage and cardiovascular events than office blood pressure (OBP) measurements and home blood pressure monitoring (HBPM). However, ABPM is expensive and is not practical for use in all patients in the outpatient setting (Shimbo et al., 2009). Home BP monitoring using an automated sphygmomanometer is practical, cost-effective, and is widely accepted as an alternative to diagnosing and managing HTN in the outpatient clinical setting (Myers & Kaczorowski, 2020).

Home BP monitoring relies on the use of technology. The development of BP telemonitoring systems was stimulated by the need for reliability of HBPM in the clinical setting (Parati & Omboni, 2010). Due to the advancing technologies that are now available, remote monitoring of clinically relevant patient parameters, such as BP and heart rate (HR), are easily

accessible to health care providers and are used to guide clinical decision making. Evidence from randomized control trials (RCTs) suggests that HBPM via telehealth, may improve BP control, increase compliance to treatment, and may help in optimizing patient's therapeutic regimen (Parati & Omboni, 2010). As practitioners and providers depend more on HBPM and the use of technology via telemonitoring, there should be confidence in the reliability and accuracy of clinically relevant patient parameters. Home BP measurements may be inaccurate due to patients' inappropriate operation of technology, withholding undesirable measurements, or inaccurate or invalidated automated devices (Fu et al., 2020). The concern for validity and accuracy of BP measurements in patients with HTN, is the driving force behind this Doctor of Nursing Practice (DNP) project.

Penn Medicine Home Health is a home care agency that services Philadelphia, Delaware, Bucks, Chester, and Montgomery counties in Pennsylvania. Telehealth monitoring is recommended for patients for a variety of reasons, including management of congestive heart failure (CHF), post-COVID symptom management, and HTN management. Patients are provided with a scale, an automated sphygmomanometer, pulse oximeter, and an electronic tablet that automatically downloads all clinical data. Patients are expected to transmit their BP, HR, oxygen saturation, and weight before 10 am every day for the telehealth nurse to view. The telehealth nurse then forwards all clinical information to the patient's provider for their review. Primary Care Providers (PCPs) and Cardiologists use this information to make clinical decisions such as weaning, titrating or discontinuing anti-hypertensive medications and other cardioactive medications. In conjunction with remote telehealth monitoring, patients are also seen by their home-visiting nurse several days per week for additional in-home support.

Telehealth nurses and home-visiting nurses communicate regularly regarding clinically

relevant patient information. Often times, telehealth nurses request that a same-day, in-home visit be made to follow up on an abnormal blood pressure reading that may be of concern. During my follow up visits with these patients, I have the patient recheck their BP using the telehealth automated sphygmomanometer they were issued. I then obtain a manual reading with my aneroid sphygmomanometer to compare the initial measurement of concern and the measurement obtained by the patient independently during my visit. The problems observe during these follow up visits are twofold: 1) The differences between the initial measurement of concern, the second measurement taken by the patient during my visit, and my manual measurement, are often times greater than 10 mm Hg for systolic blood pressure (SBP), or diastolic blood pressure (DBP), or both and 2) Patients do not follow proper BP measurement guidelines according to the AHA. These two observations lead me to ask this question: In patients with HTN who are being monitored via telehealth, how can we, as a home care agency, ensure accurate BP measurements through validated and calibrated technology, and what affect does a guideline-based educational intervention have on ensuring accurate HBPM measurements? The answer to this question becomes relevant to practitioners and providers who rely on HBPM to evaluate response to anti-hypertensive treatment.

As it currently stands, there is no known protocol or procedure at PMHH to ensure validity and accuracy of the technology we provide patients for use in the home. Automated sphygmomanometers are issued to patients by the telehealth monitoring team and it is unclear, at this time, what their process is for preparing devices for each patient. The aneroid sphygmomanometers that are used by visiting-nurses are ordered through Medline Medical Supplies, an online medical supply company, when the need for a new one arises. Inadequate sphygmomanometer maintenance and calibration is a common cause of systematic error in BP

measurements. The only way to reduce systematic errors is to use well maintained and calibrated devices (Tuner et al., 2007). Turner at al. (2007) further recommends that aneroid sphygmomanometers that are carried around daily be calibrated every 6 months and that electronic oscillometric sphygmomanometers be calibrated every year. The American Heart Association (AHA) recommends healthcare providers advise patients to use upper-arm oscillometric devices that have successfully passed validation protocols (Munter et al., 2019). In their study of 870 sphygmomanometers, Akpolat et al. (2009) found statistical significance in the prevalence of accuracy among validated devices compared to non-validated devices. For this reason, developing a protocol to ensure validity and accuracy of devices used for HBPM in telehealth patients at PMHH is of great importance.

In addition to addressing the technological issues, this DNP project seeks to address patient and clinician issues that contribute to inaccurate HBPM in patients with HTN. High quality HBPM can be achieved through structured educational interventions focused on patient education (Fu et al., 2020). In their review article, Fu et al. (2020) further describes what contributes to quality of HBPM:

> The quality of HBPM depends on a validated BP device, competence of patients to perform HBPM on their own with correct methods and frequency, a record of accurate HBPM readings, and sharing of that record with healthcare professionals (p.12).

Studies have revealed that increasing clinician-patient contact time could improve patients' knowledge, efficacy, and quality of HBPM, specifically in patients with limited health literacy (Fu et al., 2020). Nurses are usually at the frontline of blood pressure measurements and reporting of those measurements to providers. Inaccurate BP measurements can occur among health professionals, therefore recurrent and intensive guideline-based training can result

IMPROVING ACCURACY OF HOME BLOOD PRESSURE MONITORING

in significant improvement in nurses' BP measuring technique (Rabbia et al., 2013).

Interventions such as integrating a web-based continuing education program into an already

existing organizational training structure, has been shown to improve clinician knowledge of

correct blood pressure measurement techniques and sharing that knowledge with patients (Block

et al., 2018).

The overall outcome measure for this quality improvement (QI) project is to reduce

systematic errors in BP measurements, and to ensure accuracy of HBPM in patients with HTN

that are monitored via telehealth at PMHH. Accuracy of BP measurements in this population

leads to sound clinical decision-making by practitioners and providers. Using the Institute for

Healthcare Improvement (IHI) model for improvement and the Plan-Do-Study-Act (PSDA)

process, this QI project will test a protocol to ensure automated and aneroid

sphygmomanometers are well maintained, validated, and calibrated. The PSDA process will also

test a standardized educational program based on the AHA's guidelines for accurate BP

measurements for clinicians and patients. This QI improvement project will have significant

impact on patient care in primary care practice, specifically management of patients with HTN in

the primary care setting.

Discussions about this DNP project are in the beginning stages with leadership at PMHH.

I've had conversations with my direct supervisor, Marsha, about the problem I identified, why I

believe the problem is important and relevant to our patient population, and what I would like to

accomplish with this QI project. Additional key stakeholders include our agency director,

manager of the telehealth program, other team administrators, as well as members of the quality

and safety committee. More importantly, I will need by-in from the interdisciplinary team of

clinicians which include registered nurse (RNs), license practical nurses (LPNs), physical

therapists (PTs), and occupational therapists (OTs). Each member of the interdisciplinary team obtain vital signs during their respective visits, and communicate any concerns regarding clinical data with the healthcare team. Each field clinician will play a vital role in the execution and sustainability of a protocol to ensure automated and aneroid sphygmomanometers are properly calibrated and checked regularly according to evidence-based guidelines. Field clinicians will also be integral in the implementation and evaluation of a standardized guideline-based educational program that will improve knowledge, skills and attitudes towards blood pressure measurements. Introducing evidence- based practice (EBP) education in a systematic way will ensure that clinicians can truly incorporate EBP into their everyday practice (Melnyk & Fineout-Overholt, 2019). The front-line clinicians at PMHH have a direct influence on patient outcomes in the outpatient setting. Therefore, it is incumbent on the organizational leadership to understand that direct influence, and support initiatives that aide in clinician learning and implementation of EBP in the real practice environment.

To conclude, inaccurate HBPM can lead to increase healthcare costs, decrease patient quality of life, and increase morbidity and mortality. Inadequate sphygmomanometer calibration results in untreated HTN in some patients, while others, receive anti-hypertensive medications they would not otherwise receive (Turner et al., 2007). As a result, this DNP project is seeking to design and implement a protocol at PMHH to ensure accurate HBPM of patients being monitored via telehealth through sphygmomanometer calibration and proper BP measurement technique that is evidence-based. As practitioners and providers rely more on HBPM for the management of HTN, ensuring the accuracy of HBPM has become more urgent. Clinicians on the front-lines, are in a unique position to provide care that is evidence-based, which will subsequently improve the outcomes of patients with HTN that are monitored via telehealth.

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