

## **Ambulatory Blood Pressure Monitoring: Underuse in Clinical Practice in Hawai'i**

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### **Abstract**

*Hypertension is one of the leading causes of death and disability worldwide. Blood pressure reduction and control are associated with reduced risk of stroke and cardiovascular disease. To achieve optimal reduction and control, reliable and valid methods for blood pressure measurement are needed. Office based measurements can result in 'white coat' hypertension, which is when a patient's blood pressure in a clinical setting is higher than in other settings, or 'masked' hypertension, which occurs when a patient's blood pressure is normal in a clinical setting, but elevated outside the clinical setting. In 2015, the US Preventative Services Task Force recommended Ambulatory Blood Pressure Monitoring (ABPM) as the "best method" for measuring blood pressure, endorsing its use both for confirming the diagnosis of hypertension and for excluding 'white coat' hypertension. ABPM is a safe, painless and non-invasive test wherein patients wear a small digital blood pressure machine attached to a belt around their body and connected to a cuff around their upper arm that enables multiple automated blood pressure measurements at designated intervals (typically every 15 to 30 minutes) throughout the day and night for a specified period (eg, 24 hours). Patients can go about their typical daily activities wearing the device as much as possible, except when they are bathing, showering, or engaging in heavy exercise. Given the importance of blood pressure monitoring and control to population public health, this article provides details on the relevance and challenges of blood pressure measurement broadly then describes ABPM generally and specifically in the Hawai'i context.*

Cardiovascular disease is the leading cause of death in the United States. Annual cardiovascular disease costs exceed \$316 billion.<sup>1</sup> Coronary heart disease, the most common type of cardiovascular disease, results in 365,000 deaths annually.<sup>1</sup> Stroke, another form of cardiovascular disease, is the 5th leading cause of death in the United States, also results in serious, long-term disability.<sup>2,3</sup>

These are important issues in Hawai'i. Heart disease is the leading cause of death, responsible for at least three out of every ten deaths in the state.<sup>4</sup> Stroke is the 3rd leading cause of death in Hawai'i.<sup>2,3</sup> Considerable racial/ethnic disparities in cardiovascular disease and stroke also exist in Hawai'i. Compared to other races/ethnicities in Hawai'i, Native Hawaiian and Filipino men have the highest cardiovascular disease mortality at 160 and 153 per 100,000 population for Native Hawaiian and Filipino men, respectively. This rate is far higher than the cardiovascular

disease mortality of 100 per 100,000 population among white men and the Healthy People 2020 goal.<sup>4</sup> For women, coronary heart disease mortality is also highest for Native Hawaiians and Filipinos. Filipino men and women had the highest stroke mortality, at almost twice that of other races/ethnicities.<sup>4</sup>

Addressing cardiovascular disease risk is critical to improving population health and reducing health care costs. A number of lifestyle modifications and pharmacological treatment of risk factors can reduce these risks. The American Heart Association/American College of Cardiology (AHA/ACC) guidelines for cardiovascular disease prevention are highly complex and address multiple factors including hypertension, dyslipidemia, diabetes, lifestyle risk factors, and medication use.<sup>5</sup>

Of all of these, a focus on managing hypertension would be particularly fruitful for reducing morbidity and mortality. Hypertension is the leading cause of death and disability worldwide, reflecting the shift in the causes of global disease burden from communicable diseases in children to non-communicable diseases in adults.<sup>6</sup> Hypertension is also the leading cause of coronary heart disease and stroke. The impact of high blood pressure on stroke is ten times more than any other risk factor.<sup>7</sup> Predictive modeling suggests a 10% increase in treatment of hypertension could prevent 14,000 premature deaths each year.<sup>8</sup> A recent systematic review showed that adequate antihypertensive treatment as a secondary stroke prevention significantly lowered the risk of recurrent stroke, disabling or fatal stroke, and cardiovascular death. These benefits were linearly associated with the extent of both systolic and diastolic blood pressure reduction.<sup>9</sup> Moreover, a modest reduction of diastolic blood pressure by only 5 mm Hg is estimated to reduce the incidence of stroke by 32% and ischemic heart disease by 20%.<sup>10</sup>

In 2015, 32% of adults in Hawai'i had been told by a doctor that they had hypertension, and this prevalence is increasing.<sup>11</sup> Given the importance of blood pressure monitoring and control to population public health, this article provides details on the relevance and challenges of blood pressure measurement. We also describe the utility of ABPM generally and specifically in the Hawai'i context.

## **Guideline Recommendations on Screening**

The US Preventative Services Task Force (USPSTF) recommends annual screening for adults aged 40 years and older, and for those with risk factors for hypertension, including those with high-normal blood pressure, those who are overweight or obese, and African Americans. Adults aged 18 to 39 years with normal blood pressure and without other risk factors should be rescreened every 3-5 years. Such screening typically takes place in a doctor's office.

## **Office Blood Pressure Measurement**

In a health care provider's office, blood pressure is most commonly measured with a manual or automated sphygmomanometer. Although there is no consensus on the best method to measure blood pressure, many hypertension clinical trials averaged at least 2 measurements, taken when the patient was seated, after 5 minutes of sitting, and using an appropriately sized cuff with the patient's arm relaxed and the cuff at the level of heart during measurement. However, because blood pressure is affected by short-term factors, such as stress, pain, physical activity, caffeine and other drugs, there are concerns that office-based measurement of blood pressure may be inaccurate. Additionally, there may be measurement errors due to the use of a cuff that is inappropriately sized for that patient or too few measurements due to time pressures, which can also increase the risk of clinic-based hypertension results.

'White coat' hypertension, which affects approximately 36% of patients, occurs when a patient's blood pressure in a clinical setting is higher than in other settings.<sup>12-14</sup> Because patients may be falsely diagnosed with hypertension, 'white coat' hypertension can lead to overtreatment. In contrast, 'masked' hypertension occurs when a patient's blood pressure is normal in a clinical setting but elevated outside of a clinical setting. 'Masked' hypertension is estimated to be present in 17% of patients and can occur if the doctor's office is less stressful than home or other settings or if patients engage in health-related behaviors at home, such as drinking or smoking, which may increase their blood pressure. Although less common than 'white coat hypertension', 'masked' hypertension also puts patients at increased risk as it can lead to undertreatment.<sup>15-17</sup>

## **Home Blood Pressure Monitoring**

Besides office blood pressure measurement, home based blood pressure methods may be used to confirm a diagnosis of hypertension after initial screening. Home blood pressure measurement devices have become increasingly affordable and common, with many having undergone technical validation according to recommended protocols. These are also commonly used by patients with known high blood pressure. Despite its prevalence, the accuracy of home-based blood pressure measurements can be inconsistent, particularly in the absence of a standardized protocol, and comparisons to office blood pressure measurements is surprisingly sparse.

## **Ambulatory Blood Pressure Monitoring**

In 2015, the USPSTF recommended Ambulatory Blood Pressure Monitoring (ABPM) as the "best method" for measuring blood pressure and endorsed its use for confirming the diagnosis of hypertension and excluding white coat hypertension (described below).<sup>10</sup> In 2011 in the United Kingdom, the National Institute for Health and Care Excellence (NICE) recommended that ABPM be performed on all patients with suspected hypertension to confirm the diagnosis and reduce unnecessary treatment in people who do not have true hypertension.<sup>18</sup>

ABPM is a safe, painless and non-invasive test that enables multiple automated blood pressure measurements at designated intervals (typically every 15 to 30 minutes) throughout the day and night for a specified period (eg, 24 hours). Patients wear a small digital blood pressure machine that is attached to a belt around their body and connected to a cuff around their upper arm. The device will beep and then the cuff will inflate and take the patient's blood pressure. Patients are asked to go about their typical daily activities wearing the device as much as possible, except when they are bathing, showering, or engaging in heavy exercise. Guideline ABPM blood pressure goals are lower than office-based (less than 140/90): the American Heart Association suggests an ABPM 24-hour blood pressure average of less than 130/80.<sup>19</sup>

ABPM has been found to reflect more accurately a patient's blood pressure and to better predict cardiovascular risk than office-based blood pressure measurement.<sup>20-22</sup> ABPM is also able to identify 'white coat' and 'masked' hypertension. ABPM also provides other information that can help the health care provider. First, ABPM can track a patient's blood pressure response after taking medication. It also measures other conditions including: non-dipping blood pressure (ie, when a patient's blood pressure does not decrease as expected at night), nocturnal hypertension, larger than expected morning surge, blood pressure variability, and hypotension.<sup>23</sup> Patients experiencing any of these conditions may be difficult to identify using typical office-based or even home-based blood pressure monitoring, and information from ABPM may lead to appropriate changes in their medication treatment regimen.

## **Barriers to ABPM Utilization**

Despite the advantages of ABPM and its recommended use by the USPSTF, ABPM is markedly underutilized in clinical practice.<sup>20-22,24</sup> Barriers to ABPM include its expense, as health care providers or offices must purchase at least one unit to have and loan to patients (approximately between \$1500 and \$3000 per unit depending on the device and software). Unfortunately, ABPM is not commonly reimbursed for conditions other than 'white coat' hypertension and, when reimbursed, payment is low. Even for 'white coat' hypertension, there are barriers in terms of strict conditions and documentation. According to the National Coverage Decision by the Centers for Medicare & Medicaid Services (CMS), for Medicare to cover ABPM,

providers need to document suspected 'white coat' hypertension with the following: (1) Office blood pressure >140/90 mm Hg on at least three separate clinic/office visits with two separate measurements made at each visit; (2) At least two documented blood pressure measurements taken outside the office which are <140/90 mm Hg; (3) No evidence of end-organ damage.<sup>25-27</sup>

ABPM may also be burdensome to patients in that they need to wear the device for at least 24 hours. Some patients report that having the device activate at night affects their sleep patterns.<sup>28</sup> Additionally, physicians are generally unaware or unfamiliar with ABPM, and there is a lack of certification and training in ABPM implementation and interpretation, including in Hawai'i.<sup>28</sup> A recent internal quality improvement survey of 33 cardiologists and internists administered at a clinicians' conference at Queens Medical Center found only 3% of cardiologists and internists had used ABPM, with 30% reporting no knowledge, 70% some knowledge, and no one reported 'extreme' knowledge. Encouragingly, 61% reported being 'extremely interested' in learning more about ABPM, 39% were 'somewhat interested', and no one was 'not interested.'

### **Potential Impact of Payment Transformation**

Payment transformation may encourage the use of ABPM. The cost of an ABPM device may be prohibitive for a single primary care provider particularly under fee-for-service systems as the reimbursement is so low; however, public and private insurer movement toward bundled payments may encourage use of ABPM. In Hawai'i, the largest insurer has moved away from fee-for-service payment toward bundled payments and global reimbursement with performance bonuses for Primary Care Providers (PCP).<sup>29</sup> This incentivizes coordination between inpatient and outpatient care, a focus on outcomes (including blood pressure control), and health care system support of PCP. Under an Accountable Care Organization (ACO) or similar arrangement, purchasing an ABPM device may be more cost-effective because it can be used across a larger patient population than that of a single practitioner. Moreover, it may be seen as a means of achieving improved blood pressure control that may be an incentivized outcome measure for health care quality with bonus payment. There may also be shared savings involved

if reductions can be made in overtreatment of patients with 'white coat' hypertension as well as with improved treatment of patients with 'masked' hypertension.

### **Conclusion**

Despite evidence that ABPM is more accurate than office-based blood pressure measurement and more likely to predict adverse cardiovascular outcomes, ABPM is underused in clinical practice generally and specifically in Hawai'i. However, greater use may bring important health improvements on an individual patient level as well as a population level, especially to reduce health disparities given the higher rates of risk in some communities. Barriers to access, including lack of education and training, need to be addressed. Awareness in Hawai'i is low. Cost is another barrier that may be addressed as payment transformation focused on bundled payments, incentives for improved clinical quality, and shared savings may encourage use of ABPM by health care organizations. A greater emphasis on team-based care might also increase use of ABPM, as pharmacists and other allied providers might be able to educate patients on ABPM and facilitate its use. Future research is needed to assess whether routine utilization of ABPM increases the likelihood of high-risk patients, particularly in groups with known health disparities, to achieve guideline-based target blood pressure goals.

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## References

1. Benjamin EJ, Blaha MJ, Chiuve SE, et al. Heart disease and stroke statistics 2017 update: a report from the American Heart Association. *Circulation*. 2017;135:e146–e603.
2. Heart Disease and Stroke Statistics-2016 Update: A Report From the American Heart Association. *Circulation*. 2016;133(4):e38–360.
3. Centers for Disease Control. WISQARS Leading Cause of Death Reports, National and Regional. 2010. [https://webappa.cdc.gov/sasweb/ncipc/leadcaus10\\_us.html](https://webappa.cdc.gov/sasweb/ncipc/leadcaus10_us.html). Accessed June 15, 2017.
4. Hawaii State Department of Health. Hawaii's Plan for the Prevention of Heart Disease and Stroke 2011-2016. Honolulu, HI: Hawaii State Department of Health, Heart Disease and Stroke Prevention Program; 2011. [https://health.hawaii.gov/heart-disease-stroke/files/2013/12/HDSP\\_Plan.pdf](https://health.hawaii.gov/heart-disease-stroke/files/2013/12/HDSP_Plan.pdf). Accessed June 30, 2017.
5. Smith SC, Benjamin EJ, Bonow RO, et al. AHA/ACCF secondary prevention and risk reduction therapy for patients with coronary and other atherosclerotic vascular disease: 2011 update: a guideline from the American Heart Association and American College of Cardiology Foundation endorsed by the World Heart Federation and the Preventive Cardiovascular Nurses Association. *J Am Coll Cardiol*. 2011 Nov 29;58(23):2432–46.
6. Lim SS, Vos T, Flaxman AD, Danaei G, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012 Dec 15;380(9859):2224–2260.
7. Mensah GA. Epidemiology of stroke and high blood pressure in Africa. *Heart*. 2008;94(6):697–705.
8. Mozaffarian D, Benjamin EJ, Go AS, et al. Heart disease and stroke statistics—2015 update: a report from the American Heart Association. *Circulation*. 2015;131(4):e29–322.
9. Katsanos AH, Filippatou A, Manios E, et al. Blood Pressure Reduction and Secondary Stroke Prevention: A Systematic Review and Metaregression Analysis of Randomized Clinical Trials. *Hypertension*. 2017 Jan;69(1):171–179. Epub 2016 Oct 31. Law M, Wald N, Morris J. Lowering blood pressure to prevent myocardial infarction and stroke: a new preventive strategy. *Health Technol Assess*. 2003;7(31).
10. Siu AL. Screening for high blood pressure in adults: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2015;163(10):778–786.
11. Hawaii Department of Health. High Blood Pressure Prevalence. Hawaii Health Matters. <http://www.hawaiihealthmatters.org/index.php?module=indicators&controller=index&action=view&indicatorId=1249&localeId=14>.
12. Pickering TG, James GD, Boddie C, Harshfield GA, Blank S, Laragh JH. How common is white coat hypertension? *JAMA*. 1988;259(2):225–228.
13. Franklin SS, Thijs L, Hansen TW, O'Brien E, Staessen JA. White-coat hypertension: new insights from recent studies. *Hypertension*. 2013;62(6):982–987.
14. Verdecchia P, Reboldi GP, Angeli F, et al: Short- and long-term incidence of stroke in white-coat hypertension. *Hypertension*. 2005;45(2):203–208.
15. Pickering TG, Davidson K, Gerin W, Schwartz JE. Masked hypertension. *Hypertension*. 2002;40(6):795–796.
16. Peacock J, Diaz KM, Viera AJ, Schwartz J, Shimbo D. Unmasking Masked Hypertension: Prevalence, Clinical Implications, Diagnosis, Correlates, and Future Directions. *J Hum Hypertension*. 2014;28(9):521–528.
17. Franklin SS, O'Brien E, Thijs L, Asayama K, Staessen JA. Masked hypertension: a phenomenon of measurement. *Hypertension*. 2015;65(1):16–20.
18. McManus RJ, Caulfield M, Williams B. National Institute for Health and Clinical Excellence (NICE) hypertension guideline 2011: evidence based evolution. *BMJ*. 2012;344:e181.
19. Pickering TG, Hall JE, Appel LJ, et al. Recommendations for blood pressure measurement in humans and experimental animals: Part 1: Blood pressure measurement in humans: A statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. *Circulation*. 2005;111(5):697–716.
20. Dolan E, Stanton A, Thijs L, et al. Superiority of ambulatory over clinic blood pressure measurement in predicting mortality: the Dublin outcome study. *Hypertension*. 2005;46:156–161.
21. Ingelsson E, Bjorklund-Bodegard K, Lind L, Arnlöv J, Sundstrom J. Diurnal blood pressure pattern and risk of congestive heart failure. *JAMA*. 2006;295:2859–2866.
22. Schmieder RE, Lehmann MV, Schmidt S. Optimizing blood pressure control in hypertension: The need to use abpm. *Blood Press*. 2013;22:65–72.
23. Shimbo D, Abdalla M, Falzon L, Townsend RR, Muntner P. Role of Ambulatory and Home Blood Pressure Monitoring in Clinical Practice: A Narrative Review. *Ann Intern Med*. 2015;163(9):691–700. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4638406>. Accessed June 1, 2017.
24. White WB, Gulati V. Managing hypertension with ambulatory blood pressure monitoring. *Curr Cardiol Rep*. 2015;17(2):2.
25. O'Brien E, Parati G, Stergiou G, et al. European Society of Hypertension position paper on ambulatory blood pressure monitoring. *J Hypertens*. 2013;31(9):1731–68.
26. Kent ST, Shimbo D, Huang L, et al. Rates, amounts, and determinants of ambulatory blood pressure monitoring claim reimbursements among Medicare beneficiaries. *J Am Soc Hypertens*. 2014;8(12):898–908.
27. Centers for Medicare and Medicaid Services. National Coverage Determination (NCD) for Ambulatory Blood Pressure Monitoring (20.19). [https://www.cms.gov/medicare-coverage-database/\(S\(awjbae45o10tftb2ojw0mjve1\)\)/details/ncd-details.aspx?NCDId=254&ncdver=2&NCAId=5&ver=6&TAlD=27&NcaName=Ambulatory+Blood+Pressure+Monitoring&bc=BEAAAAAAEAgA&](https://www.cms.gov/medicare-coverage-database/(S(awjbae45o10tftb2ojw0mjve1))/details/ncd-details.aspx?NCDId=254&ncdver=2&NCAId=5&ver=6&TAlD=27&NcaName=Ambulatory+Blood+Pressure+Monitoring&bc=BEAAAAAAEAgA&)
28. Viera AJ, Lingley K, Hinderliter AL. Tolerability of the Oscar 2 ambulatory blood pressure monitor among research participants: a cross-sectional repeated measures study. *BMC Med Res Methodol*. 2011;11:59.
29. Hawaii Medical Service Association. Transforming physician compensation. [https://hmsa.com/portal/provider/Payment\\_Transformation\\_Overview\\_for\\_PCPs\\_and\\_Staff\\_in\\_Pilot\\_Program\\_031016.pdf](https://hmsa.com/portal/provider/Payment_Transformation_Overview_for_PCPs_and_Staff_in_Pilot_Program_031016.pdf). Accessed September 25, 2017.