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Ambulatory Blood Pressure Monitoring: A Complimentary Strategy for Hypertension Diagnosis and Management in Low and Middle-income Countries

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Abstract

Ambulatory blood pressure monitoring (ABPM) can assess out-of clinic blood pressure. ABPM is an underutilized resource in low and middle-income countries but should be considered as a complimentary strategy to clinic blood pressure measurement for the diagnosis and management of hypertension. Potential uses for ABPM in low and middle-income countries include the use of ABPM for the screening of high-risk individuals who have concurrent communicable diseases such as HIV and the use of ABPM in task-shifting healthcare strategies.

Keywords

ambulatory blood pressure monitoring; resource-constrained; low and middle income countries

Introduction

Worldwide, the burden of hypertension is increasing especially within low and middle-income countries (LMICs).[1] While the prevalence of hypertension within LMICs is high, awareness and control is often low.[2-4] The current burden of hypertension is greatest in populations within LMICs where approximately 1 out of every 3 adults is affected by hypertension. Furthermore, it is projected that LMICs will continue to bear a higher burden of the disease when compared to the global average and by 2025, 75% of individuals with hypertension will be living in LMICs.[6] Clearly, hypertension is an important public health problem within LMICs and effective strategies to diagnose and treat hypertension are needed. Indeed, the reduction of hypertension by 25% by the year 2025 is now a World Health Organization (WHO) priority.[7]

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Although the diagnosis and treatment of hypertension has historically been based on the measurement of blood pressure (BP), via automated oscillometric or manual readings, taken within the clinic setting, more recently, the WHO recommends that BP be recorded for several days, ideally with two measurements made in the morning and evening with additional BP measurements done outside the clinic setting in order to properly diagnosis hypertension.[8] Because BP is characterized by a circadian pattern over a 24-hour period with levels that are normally highest while awake and fall during sleep, clinic BP readings may not accurately reflect BP taken outside of the clinic setting. Although both ambulatory blood pressure monitoring (ABPM) and home blood pressure monitoring can assess BP outside of the clinic setting,[9] ABPM is more commonly recommended within several international guidelines.[10-13] Additionally, studies have shown that ambulatory BP provides a better prediction of several cardiovascular (CV) outcomes when compared to clinic BP.[13-17]

Overview of Ambulatory Blood Pressure Monitoring

Ambulatory BP monitors are compact automated oscillometric devices, worn on a belt or pouch and connected to a sphygmomanometer cuff on the upper arm by a tube (Fig 1). These monitors are typically worn for a 24-hour period and are set to obtain readings every 15 to 30 minutes throughout the day and night. During the 24-hour monitoring period, individuals are also encouraged to fill out a diary to document times of meal and medication ingestion, sleep and awakening, exercise, or any symptoms. After the 24-hour period, the monitor is returned and readings are downloaded into a computer for processing.[9]

Because ABPM can provide multiple BP measurements throughout a 24-hour period, average BP readings can be assessed over several discrete time periods, including the daytime, nighttime, and 24-hour periods.[18] The daytime and nighttime periods can be defined using several different approaches including an individual's self-report of awakening and sleeping times, fixed time periods, or actigraphy.[9,19-21] Accordingly, daytime, nighttime, and 24-hour hypertension may be diagnosed by obtaining elevated BP readings during any of these time periods. Daytime hypertension is defined as mean daytime systolic BP ≥ 135 mmHg or mean daytime diastolic BP ≥ 85 mmHg, nighttime hypertension is defined as mean nighttime systolic BP ≥ 120 mmHg or mean nighttime diastolic BP ≥ 70 mmHg and 24-hour hypertension is defined as mean systolic BP ≥ 130 mmHg or mean diastolic BP ≥ 80 mmHg[21].

ABPM can be used to diagnose hypertension as well as manage antihypertensive therapy among individuals with hypertension. When ambulatory BP readings are cross-classified with clinic BP readings, there are 4 BP phenotypes that can be defined (Figure 2). Sustained normotension and sustained hypertension represent agreement between clinic BP and ambulatory BP readings. White coat hypertension is defined as elevated clinic BP with non-elevated ambulatory BP readings[21,22] whereas masked hypertension is defined as non-elevated clinic BP with elevated ambulatory BP readings (either in the daytime, nighttime, or throughout the 24-hour period).[21,23] Whether white coat hypertension is linked to increased CV risk and mortality has been controversial within the literature.[24-26] In contrast, several studies have shown that masked hypertension is associated with subclinical target organ damage, incident hypertension, and increased CV and total mortality.[16,27-29]

ABPM can also be used to identify white coat hypertension and masked hypertension among treated individuals on antihypertensive therapy.[9] Treated white coat hypertension or white coat uncontrolled hypertension can occur among individuals on antihypertensive medications who have elevated clinic BP with non-elevated ambulatory BP whereas treated masked hypertension or masked uncontrolled hypertension can occur among individuals on antihypertensive therapy who have non-elevated clinic BP with elevated ambulatory BP.

In addition to these 4 BP phenotypes, several other diurnal BP patterns and BP measures such as nocturnal dipping, blood pressure variability, morning surge, and orthostatic hypotension can also be defined. During sleep, BP normally decreases or "dips" when compared to awake BP. Individuals can be classified into two dipping groups (dipping or non-dipping) as well as into four dipping patterns (extreme dipping, normal dipping, non-dipping, or reverse dipping) based on the nighttime-daytime systolic BP ratio. When classified into two dipping groups, several studies have shown that non-dipping BP is associated with increased target organ damage as well as increased risk of mortality.[30-33] Likewise, studies have also shown that non-dipping pattern and reverse dipping pattern are each associated with increased mortality and CV events when compared to normal dipping pattern.[31,34-37] Similarly, BP normally increases ("surges") upon awakening when compared to sleep BP. An exaggerated morning surge has been associated with an increased CV risk.[38] Thus, ABPM can provide detailed assessment of several BP phenotypes and measures which can be helpful in the prediction of clinical outcomes.[14,18]

The Potential Applicability and Current Use of Ambulatory Blood Pressure Monitoring in LMICs

Within LMICs, healthcare systems are often underfunded and incur a double burden of communicable and non-communicable diseases leading to competing healthcare priorities. Additionally, most healthcare systems in resource-constrained areas are not equipped to deal with the long-term management of chronic conditions such as hypertension. Within certain LMICs, where communicable diseases such as HIV and tuberculosis are at the forefront of healthcare system priorities, there has been an opportunity to leverage existing communicable healthcare delivery systems to address non-communicable diseases.[39] In fact, screening for these communicable diseases has created an infrastructure for "opportunistic" screening and treatment for non-communicable diseases which has been shown to be cost-effective.[39,40] Most population-wide screening initiatives to diagnose hypertension within LMICs have relied on elevated clinic BP readings. While the use of ABPM in population-wide screening programs in LMICs has not been formerly examined, ABPM can be a complimentary strategy to confirm initially elevated clinic BP readings[41] especially among high risk individuals who are undergoing screening or management of communicable diseases. An example of this includes individuals with HIV who have been shown to be at an increased risk for CV diseases (CVD), including hypertension.[42] Although studies of ABPM in HIV^+ individuals are limited, HIV^+ individuals have an increased prevalence of non-dipping BP[43] which may put them at increased risk for CV events. Identifying the factors associated with abnormal BP phenotypes within HIV^+ individuals would help elucidate the mechanisms underlying the excess CVD risk among this population and potentially identify

new targets for intervention that can mitigate this excess risk. Thus, the use of ABPM among high risk individuals can be part of a comprehensive healthcare strategy to address the double burden of disease within LMICs.

Besides the double burden of communicable and non-communicable diseases, there is also a shortage of well-trained healthcare providers in LMICs. As such, “task shifting”-the delegation of tasks to non-physician healthcare providers such as nurses and pharmacists-is now an effective strategy used in the management of several conditions within LMICs to help address the shortage of healthcare providers.[44,45] Task shifting strategies have been implemented both in chronic communicable diseases such as HIV/AIDS as well as non-communicable disease conditions such as diabetes and hypertension.[46-51] However, few studies have examined the use of ABPM as part of task shifting strategies. In a recent study, James et al.[52] demonstrated the feasibility of a pharmacist-led hypertension management strategy using ABPM in Ireland. In both high-income and LMICs, pharmacists are increasingly being included within the healthcare team. Within LMICs, pharmacists play a critical role within communities. In some areas, local pharmacies may be the only health service available.[53] The local pharmacist often has several responsibilities within resource-constrained areas that include: advising individuals on the management of common conditions, prescribing and dispensing medication, and participating in basic screening and health promotion activities.[53] Local community members often develop a long-term relationship with their pharmacists who are viewed as a trusted and accessible resource. In turn, patient engagement with their own healthcare is high.[54] Adoption of a pharmacist-led hypertension management strategy using ABPM within LMICs may prove effective and may increase availability of ABPM within resource-constrained areas.

Despite the utility of ABPM, there is currently underutilization of ABPM within LMICs. In a small cross-sectional survey of national and regional hypertension societies, only 36% of respondents within LMICs reported use of ABPM.[55] This may be due to various challenges both on an individual level as well as on a systematic level that may be unique to resource-constrained settings. For some individuals, use of ABPM at night may interrupt sleep.[9] Rarely, repeated inflation of the device over the 24 hours can cause skin irritation. Although prior studies have shown that when compared to home BP and clinic BP, ABPM is a cost-effective strategy for the diagnosis and treatment of ABPM within high-income countries,[56] the initial cost of ABPM devices are generally higher when compared to other automated BP devices[18,56] including home BP devices. This may be an additional financial burden to individuals in resource-constrained areas where often the majority of healthcare is paid via private spending.[39] Additionally, devices have to be returned to centers within a timely manner for processing which may be burdensome for individuals who may have limited interaction and infrequent access to healthcare systems. Once an individual returns the ABPM device, the data must be downloaded onto a computer and processed via software for analysis and the generation of clinical reports. Besides the direct cost of computers and software programs for analysis, there is some level of clinical expertise required to oversee proper post-processing interpretation of data. Currently, formal training programs and certification on the use of ABPM do not exist in many centers and thus quality standards for ABPM may vary across sites and regions.

Despite these challenges, the majority of recent guidelines, including the American Society of Hypertension/International Society of Hypertension 2014 guidelines[12], National Institute for Clinical Excellence 2011 guidelines[11], and the European Society of Hypertension/ European Society of Cardiology 2013 guidelines[10], have recommended the use of ABPM most commonly to exclude white coat hypertension. However, most of the normality thresholds for ambulatory BP published within these guidelines have been derived from European and Japanese population-based and hypertensive cohorts.[57-63] Whether normality thresholds for ambulatory BP are similar in populations with a high risk of hypertension-related adverse CV outcomes is currently unknown since some studies suggest that the risk of hypertension, BP treatment thresholds, and appropriate antihypertensive medication regimens vary with ethnic origin.[6,64-67]

Unfortunately, most of the published ABPM studies originating from investigators in LMICs are often country-specific and pooled population-based data from LMICs is currently not available. In contrast, one of the largest population-based ABPM cohorts is the International Database of Ambulatory blood pressure in relation to Cardiovascular Outcome (IDACO) study[68], which incorporates data from 12, 752 participants from 12 high-income countries in Europe, Asia, and South America. Additionally, the international ambulatory blood pressure registry: telemonitoring of hypertension and cardiovascular risk project (ARTEMIS)[69] is a large international registry of centers utilizing ABPM in the management of hypertensive patients from 41 countries, including 12 LMICs. Studies from both IDACO and ARTEMIS have helped define the prognostic value of ABPM and ethnic differences in ambulatory BP measures.[68,70]

Future Areas of Research

There are many important research questions related to ABPM that still remain unanswered. As previously mentioned, the feasibility of ABPM for large-scale hypertension screening and treatment campaigns is unknown. Defining the prevalence of ambulatory BP phenotypes and their relation to incident hypertension and target organ damage must still be elucidated within different ethnically-diverse populations. It is also currently unclear whether the addition of ambulatory BP to clinic BP or home BP measurements provides further improvement on CV risk estimates.[14] Additionally, whether the initiation and titration of antihypertensive therapy based on clinic and ambulatory BP improves CV outcomes when compared to clinic BP alone is unknown.[14] Lastly, data on the cost-effectiveness of ABPM is scarce and has been limited to studies mostly from the UK, US, Japan, and Australia.[56,71-75]

Conclusion

Given the low awareness rates of hypertension in LMICs, most population-wide screening initiatives have relied on elevated clinic BP readings to confirm a diagnosis of hypertension.[76,77] However, clinic BP may not accurately capture the diurnal variation of BP over a 24-hour period. Additionally, failure to confirm elevated clinic BP readings can result in overtreatment and misdiagnosis.[41] Given the limited availability of ABPM data in LMICs, there is an urgent need for evidence-based epidemiological and global health delivery

research within this area. The use of ABPM should be considered as part of a comprehensive healthcare approach to reduce the growing burden of hypertension within LMICs which now mandates additional strategies beyond the traditional assessment of clinic BP.

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Key Points

- The burden of hypertension is increasing worldwide.
- Out-of-clinic blood pressure assessments, including ambulatory blood pressure monitoring (ABPM), are recommended by several international guidelines.
- Ambulatory blood pressure provides a better prediction of several cardiovascular outcomes when compared to clinic blood pressure.
- ABPM can be used as part of a comprehensive healthcare strategy to address the double burden of communicable and non-communicable diseases and as part of task-shifting strategies in the management of hypertension within low and middle-income countries.

Figure 1.

The ambulatory blood pressure monitor can be worn on a belt or pouch and is connected to a sphygmomanometer cuff on the upper arm. Courtesy of Marwah Abdalla.

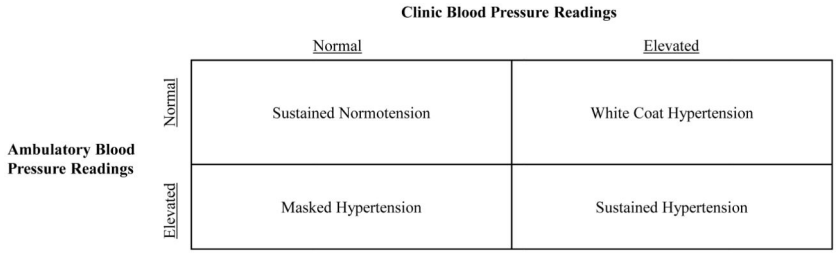

Figure 2.

The four blood pressure phenotypes defined by cross-classification of clinic blood pressure and ambulatory blood pressure.