The diagnosis of hypertension has traditionally been limited to office blood pressure readings. The advent of electronic blood pressure monitors has provided additional instruments to better profile a patient’s blood pressure. Ambulatory Blood Pressure Monitoring (ABPM), involving a blood pressure monitor worn continuously by a patient over a 24 to 48 hour period, provides the most comprehensive profile of a patient’s blood pressure. ABPM is indicated in individuals with suspected White-Coat Hypertension or Resistant Hypertension and is a potentially valuable diagnosis modality. It provides high temporal resolution with unbiased reporting of blood pressure to the physician. In addition, it is better able to characterize nocturnal blood pressure, something not possible with office or home/self blood pressure recordings. The Canadian Hypertension Education Program (CHEP) has defined ABPM thresholds of hypertension to be greater than 135/85 mmHg mean awake BP or greater than 130/80 mmHg for mean 24hr BP’s. These thresholds are lower than the traditional office thresholds of 140/90 mmHg. ABPM results can be used to reduce unnecessary anti-hypertensive therapy as well as modify dose scheduling to cover ‘blind spots’ in blood pressure regulation. It can also provide additional diagnostic information regarding the contributing factors to a patient’s resistant hypertension. For the time being, ABPM is only moderately cost-effective under certain clinical indications and thus is unfunded by OHIP. Nonetheless, it remains an additional dimension to hypertension diagnosis that all healthcare professionals should be aware of.

This article has been reviewed by Dr. Louise Moist.

Introduction

Hypertension, as defined by the Canadian Hypertension Education Program (CHEP), is considered as a systolic blood pressure (SBP) of 140mmHg or higher and a diastolic blood pressure (DBP) of 90mmHg or higher. It affects 27% of the Canadian adult population between the ages of 35 and 64. Hypertension is the most important risk factor for stroke as well as the leading preceding condition to heart failure. It is also a noted risk factor for heart attacks, arterial aneurysms, and chronic renal failure.

Blood Pressure Variability

Blood pressure does express some normal variability with research by Millar-Craig et al. establishing the circadian variation of blood-pressure. Blood pressure ordinarily peaks during mid-morning, is lowest at night, and rises before awakening. 25-35% of patients do not express a dip in blood pressure at night and are termed ‘non-dippers’. Patients without this dip have been associated with increased sympathetic activity during sleep, worse prognosis, and elevated risk of end-organ injury such as progressive renal insufficiency.

White-Coat Hypertension

A clinical phenomenon, known as white-coat hypertension (WCHT), exists whereby an individual’s blood pressure rises in response to anxiety brought on by a visit to a physician’s office. A common definition of WCHT is a high blood pressure (BP) in a physician’s office with a normal BP at rest or while ambulatory. This can either be defined in the short-term as BP just before and during a visit or in the long-term as the change between a daily average BP versus BP during a visit. In addition, there should be no end-organ damage in order for WCHT to be diagnosed.

Conventional and Home/Self Blood Pressure Monitoring

Conventional blood pressure monitoring most classically takes on the form of the mercury or aneroid sphygmomanometry performed in the physician’s office. Collectively termed as office blood pressure (OBP)
values or casual blood pressure readings, they provide a snapshot of a patient’s blood pressure as performed by a trained professional.

In recent years, there has been movement towards home blood pressure monitoring or self-blood pressure monitoring to serve as an adjunct to office blood pressure values. Fully automated electronic blood pressure monitors are the most commonly marketed for their ease-of-use and lack of reporting bias from the patient. While effective in some capacities, limitations exist in terms of clinical validation of individual devices as well as variable measurement schedules and number of recordings performed by the patient.

**Ambulatory Blood Pressure Monitoring (ABPM)**

Ambulatory Blood Pressure Monitoring (ABPM) differs from conventional blood pressure monitoring in that an electronic blood pressure monitoring device is worn continuously by a patient with readings taken at regular intervals (Figure 1; Figure 2). ABPM originally came about as a research tool with the first recorded mention of such a device in 1962. The very first study that established the superiority of ambulatory blood pressure readings was performed using a modified version of the 1962 device by Sokolow and colleagues in 1966. Since that time, ABPMs have come into greater clinical use and are now specifically recommended by Canadian and American cardiovascular societies under certain indications.

ABPM devices function by either directly listening to and interpreting Korotkoff sounds using a microphone, not unlike conventional blood pressure monitoring, or through the sensation of vibratory signals while the pressure cuff inflates. Pressure readings are usually collected at 15 to 30 minute intervals and stored on a computer chip for later viewing and interpretation by the physician. This provides the clinician with an unbiased and detailed review of the patient’s blood pressure, usually over a 24 to 48 hour study period.

**Interpretation of ABPM Results**

The interpretation of results from ambulatory blood pressure measurement is slightly different from traditional office blood pressure values. According to the 2007 Canadian Hypertension Education Program (CHEP) guidelines, a diagnosis of hypertension can be made from ambulatory blood pressure monitoring “if the mean awake SBP [Systolic Blood Pressure] is 135 mmHg or higher or the DBP [Diastolic Blood Pressure] is 85 mmHg DBP or higher”. An alternate determination of hypertension can be made if the mean 24 hour blood pressure is “130 mmHg or higher or the DBP is 80mmHg or higher” (Figure 3) Of note is that these thresholds are slightly lower than the common 140/90 mmHg traditionally set for office blood pressures. This is to be expected given the repeated averaged measurements and the minimization of any potential White-Coat effect.

**Clinical Indications for ABPM**

Given the additional costs incurred in utilizing ABPM, researchers and clinicians have devised specific indications for its utilization. The most often cited indication is suspicion of white-coat hypertension. Individuals with ambiguous hypertension (i.e. normotensive home blood pressure readings and hypertensive office blood pressure readings) can also be better managed with ABPM data. There are estimates that between 20 to 30 percent of individuals found to be hypertensive in a physician’s office are normotensive at other times. By recognizing these individuals as normotensive or pre-hypertensive, a reduction in antihypertensive medications, side effects, and excess costs can be realized.

Another candidate for ABPM is resistant hypertension, when blood pressure control is not achieved despite adequate and sustained anti-hypertensive therapy. This typically presents as elevated office blood pressure, normal home readings, and a lack of apparent target-organ damage. One etiology of resistant hypertension especially suited to 24h ambulatory monitoring is sleep apnea. Hypertensive episodes can occur as a result of apneic spells. On ABPM, this would demonstrate as a lack of a nocturnal blood pressure dip, a finding not as easily obtained with office or home blood pressure monitoring.

Finally, as clinical research progresses and ABPM usage becomes more commonplace, we may see the general usage of ABPM in all hypertensive patients. Already, there is significant evidence that ABPM readings may be a better predictor of end-organ damage, cardiovascular events, and mortality than office blood pressures. As nocturnal blood pressures also appear to play a prognostic role, ABPM is able to record what conventional office blood pressure and casual home blood pressure recordings do not. In addition, the 24h coverage of ABPM can notify a physician of ‘blind spots’ in hypertensive coverage, necessitating a change in anti-hypertensive medications or dose scheduling.
Costs & Availability of ABPM

For an typical physician’s office, purchasing a monitor and associated software can range on average from $4,500 to $5,500 USD. ABPM is not currently funded by OHIP and as such there is a nominal cost associated with its clinical usage. Canadian clinics and hospitals typical charge a user fee of $50 to $75 CDN per ABPM study. In comparison, Medicare and Medicaid in the United States has reimbursed the cost of ABPM for patients with a suspected diagnosis of White-Coat Hypertension.

There have been mixed results regarding the cost-effectiveness of ABPM. The original study recommending Medicare and Medicaid support of ABPM for suspected White-Coat Hypertension patients was based on the avoidance of anti-hypertensive drug adverse effects as well as the better assessment of cardiovascular risk that ABPM would offer for the physician. In support of the cost-effectiveness of ABPM is a study by Krakoff that projects savings for the usage of ABPM where annual treatment costs total a minimum of $300. This conclusion operates on the assumption that a fraction of patients diagnosed with White-Coat Hypertension would discontinue treatment. In another study by Rodriguez-Roca et al., ABPM was found to be only more cost-effective than conventional blood pressure monitoring when the new treatment cost of poorly monitored patients was not included.

Conclusion

Hypertension represents a significant issue in modern healthcare with an aging population and ambulatory blood pressure monitoring remains the most accurate diagnostic modality available. While ideal to use in all patients with suspected hypertension, cost-effectiveness guidelines only seem to support its use in narrow indications. In this regard, Canada is slightly behind the United States in terms of public funding. However, in comparison with many other diagnostic technologies, a single ambulatory blood pressure study is not nearly as prohibitive in cost. For the time being, awareness of this technology and its appropriate indications for use by all healthcare professionals is advised with ambulatory blood pressures adding another valuable dimension to the monitoring of hypertensive patients.

References


Figures

**FIGURE 1:** Ambulatory blood pressure monitor and cuff (Model 90207, SpaceLabs Medical, Inc., Issaquah, Wash.)

**FIGURE 2:** Individual wearing an ambulatory blood pressure monitor.

**FIGURE 3:** Threshold guidelines for Ambulatory Blood Pressure Monitoring (ABPM) utilizing averaged blood pressure measurements over the duration of a study; SBP Systolic BP; DBP Diastolic BP. Adapted from the Canadian Hypertension Education Program.