24-Hour Ambulatory Blood Pressure Monitoring in Primary Care

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Background: **Both the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of Hypertension in Adults and the British Hypertension Society have made recommendations for the use of ambulatory blood pressure monitoring (ABPM) in select patient populations. This demonstration project explores the feasibility of a 24-hour ABPM service in assisting physicians with decisions regarding the implementation and modification of antihypertensive therapy.**

Methods: **After physician referral, patients met with a pharmacist for evaluation of their blood pressure. The pharmacist obtained a medication profile and instructed each patient on the proper use of the monitor. Patients completed an activity diary while wearing the monitor. After analysis of the reports, the pharmacist forwarded recommendations and the 24-hour blood pressure data to the referring physician.**

Results: **Sixty patients took part in the demonstration project. The primary reasons for referral included evaluation of suspected isolated office hypertension, drug resistance, blood pressure control in diabetic patients, and suspected drug-induced orthostatic hypotension. The referring physicians accepted 100% of the pharmacists' therapeutic recommendations. Unnecessary therapy was avoided in 12 of 40 of patients with suspected isolated office hypertension (30%), and more aggressive treatment was started in 6 of 7 of patients with type 2 diabetes (87.5%).**

Conclusions: **This project shows that a 24-hour ABPM consultation service can provide useful information for determining which patients have isolated office hypertension and in guiding drug regimen modification for patients with diabetes, suspected resistant hypertension, or drug-induced alterations in blood pressure. (J Am Board Fam Pract 2001;14:166–71.)**

The use of 24-hour ambulatory blood pressure monitoring (ABPM) in the clinical setting has been gaining acceptance for a number of reasons.[1] First, clinic blood pressure measurements often overestimate a patient's baseline blood pressure value.[2] This isolated office hypertension has been found to occur in up to 32% of patients.[3,4] Second, 24-hour ABPM provides a means of delineating circadian variations in blood pressure.[5] On arising, a neurohormonal surge is associated with higher blood pressure values during the first few hours of the wake cycle.[6] This process contributes to the higher incidence of cardiovascular sequelae, including myocardial infarction.[7]

Throughout the course of a day, numerous extenuating circumstances (emotions, activity, and work, among others), can alter blood pressure as well. An additional benefit of ABPM is determining what percentage of the day blood pressure is elevated above predefined normotensive values (ie, blood pressure load). Two approaches have been used to determine blood pressure load. The first approach calculates blood pressure load by determining the percentage of blood pressure readings higher than 140/90 mm Hg during the entire 24 hours. The second approach determines the percentage of blood pressure readings higher than 140/90 mm Hg during the day and the percentage of readings higher than 120/80 mm Hg at night.[8] Elevated blood pressure load correlates with end organ damage, such as ventricular hypertrophy and proteinuria.[8,9]

Several clinical trials have provided evidence that ABPM is "particularly valuable to refine car-

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diovascular risk stratification in untreated subjects with office hypertension and in those with resistant hypertension."[10] In a normotensive person, ABPM should show mean values less than 135/85 mm Hg during waking and less than 120/75 mm Hg during sleeping hours.[11,12] Thus, a patient's overall blood pressure status can be more fully assessed with 24-hour ABPM than with clinic blood pressure measurements. Although not indicated for every patient, 24-hour ABPM can be a useful tool in the evaluation and treatment of hypertension.

The sixth report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI) supports the use of 24-hour ABPM for patients whose blood pressure readings conform with one of the following five categories: (1) suspected isolated office hypertension, (2) autonomic dysfunction, (3) drug-induced orthostatic hypotension, (4) episodic hypertension, or (5) resistant hypertension (blood pressure $>$ 140/90 mm Hg, or $>$ 160 mm Hg for isolated systolic hypertension on an almost maximum dose of a triple-drug regimen, including a diuretic). Various practitioners also use 24-hour ABPM to characterize more fully the hypertensive profiles of selected patients.[13]

A MEDLINE search failed to find any published studies describing the role of 24-hour ABPM in the office setting to improve management of suspected or established hypertension in their patients. This article describes an interdisciplinary approach to evaluating and managing hypertension with the aid of 24-hour ABPM. A clinical pharmacy consultation service was established to assist physicians in evaluating or optimizing the blood pressure control of patients who met the JNC VI criteria for 24-hour ABPM. Long-term plans include a pharmacoeconomic evaluation of this service. Eventual reimbursement from third party payers is dependent on cost justification.

Methods

Physicians in the geriatrics, cardiology, and family practice clinics at the University of Arkansas for Medical Sciences were notified about the availability of a 24-hour ABPM consultation service. A 1-hour presentation and question-and-answer session was conducted to inform and educate physicians in these clinics about the use of 24-hour ABPM according to JNC VI criteria. Although the primary interest was the evaluation of patients based on JNC VI guidelines, physicians were free to refer any patient who they believed would benefit from 24-hour ABPM.

Twenty-four hour blood pressure monitors use one of two technologies to record blood pressure. One method uses a microphone to detect Korotkoff sounds. The other method uses oscillations, or vibrations, of the brachial artery to determine systolic and mean blood pressure.[13] The point of maximal oscillation corresponds to the mean arterial blood pressure. Both systems are noninvasive and use an arm cuff that is inflated at predetermined programmable intervals. SpaceLabs monitors, model 90207 (Redmond, Washington), were used for this service. The accuracy and dependability of these monitors are well documented in the literature.[1,14] After the 24-hour recording was completed, a report was generated by a computer interface with the monitor. The report included tabular and graphic representation of all measured blood pressures, as well as an analysis of the readings during various periods throughout the day. Figure 1 displays a graphic representation of a 24-hour ABPM recording.

All monitors were programmed to record blood pressure readings every 30 minutes during normal awake hours and every 60 minutes during normal sleep hours, as reported by the patients before the monitoring period began. The pharmacist then obtained a current medication profile from each patient. Patients were taught to place and remove the cuff, to turn the monitor on and off, and to care for the device. The monitor was then placed on the patient's nondominant arm, turned on. Patients were supplied with activity diaries for recording medication administration times, any exertional activities, approximate sleep time, and any other information they deemed pertinent (eg, possible symptoms of increased blood pressure). This information could then be correlated to the 24-hour computer-generated blood pressure report to account for any inconsistent readings (eg, outliers secondary to exercise). All patients were encouraged to adhere to appropriate lifestyle modifications regardless of their blood pressure level.

Each pharmacist participating in the ABPM service was trained to initialize the monitors and ensure that they were accurately calibrated. The pharmacists were also trained to place the cuff accurately and to instruct patients regarding the

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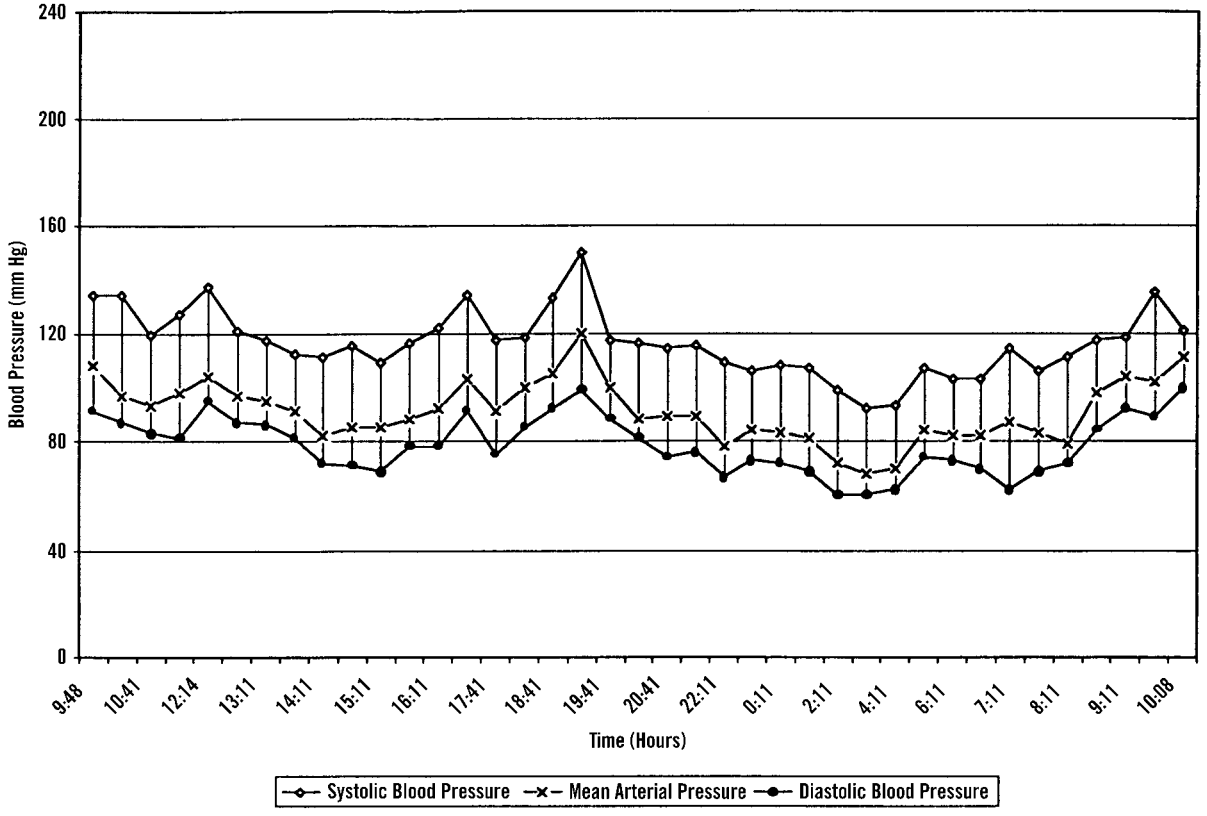

Figure 1. Example of a 24-hour ambulatory blood pressure graph of a normotensive patient evaluated for suspected isolated office hypertension. Based on a mean systolic and diastolic blood pressure decrease of 13.3% (awake) and 17.1% (sleep), this patient depicts a normal diurnal profile dip (variation). Mean 24-hour, daytime, and nighttime blood pressure values are 115/77, 120/82, and 104/68 mm Hg, respectively.

proper care of the monitors. The director of the service was a clinical pharmacist with extensive ABPM experience through her involvement with various clinical trials in hypertensive populations.

Physician acceptance of the service was based on the number of treatment recommendations implemented as a percentage of those received. Implementation of the recommendations for patients with suspected isolated office hypertension consisted of delaying therapy in those with confirmed isolated office hypertension and instituting therapy in those with confirmed hypertension.

Data Analysis

A report was not considered complete unless at least 32 of 40 possible readings were acceptable (80%). If the report was incomplete, the patient wore the monitor again. Data editing was restricted to eliminating physiologically impossible pressures, such as when the diastolic pressure equaled the systolic pressure. Although deciding what constitutes normal ambulatory blood pressure is controversial, for purposes of clinical decision making, we considered a mean daytime ambulatory blood pressure of less than 135/85 mm Hg, despite office measurements of more than 140/90 mm Hg, to constitute office hypertension.[15]

Results

Sixty patients were referred to the 24-hour ABPM clinic during the 13-month study period. Table 1 displays the patients' demographic data. The reasons given for monitoring included isolated office hypertension (66.7%), drug resistance (13.3%), non–insulin-dependent diabetes (11.7%), and miscellaneous (8.3%). All 60 patients had ABPM reports that could be evaluated, as defined by a minimum of 32 readings during the 24-hour period during their first monitoring attempt. The monitor was well tolerated by all patients. Patient diaries were not useful in accounting for outliers during

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Table 1. Patient Demographics.

Characteristic	Number
Sex	
Male	27
Female	33
Age (mean ± SD)	
Male	59.3 ± 10.8
Female	61.8 ± 14.6
Antihypertensive therapy (agents per patient)	
0	26
1	17
2	9
3	6
4	2
Indications for ABPM	
Isolated office hypertension	40
Resistant hypertension	8
Non-insulin-dependent diabetes mellitus	7
Miscellaneous	5

ABPM - ambulatory blood pressure monitoring.

data interpretation because of incomplete records of activity.

Of the 40 patients who were suspected of having isolated office hypertension, 12 (30%) were confirmed to have a component of isolated office hypertension. These 12 patients had hypertensive readings in the clinic, but based on mean 24-hour, daytime, and nighttime blood pressure readings, they were normotensive. Eight patients were monitored for suspected resistant hypertension. Of these, only 1 patient was found to have true resistant hypertension as defined by JNC VI criteria. Of the other 7 patients with suspected resistant hypertension, 3 were still classified as having hypertension (2 had stage 2 and 1 had stage 1)[10] but did not meet the criteria for resistant hypertension.[14]

Seven patients had a comorbid illness, ie, type 2 diabetes mellitus. Based on the JNC VI recommendation for optimal blood pressure control with diabetes of < 130/85 mm Hg, only 1 patient was found to have an adequately controlled mean blood pressure. The other 6 diabetic patients warranted more aggressive intervention for adequate blood pressure control.

One elderly patient had suspected drug-induced orthostatic hypotension after his blood pressure dropped during the early morning hours. This condition was confirmed by a 2 AM diastolic drop of 15.9 mm Hg, which correlated with her evening dose of long-acting propranolol. She also had a dip in blood pressure of 22.1 mm Hg at noon as a result of her morning propranolol dose.

The pharmacists' recommendations, as well as the percentage of physician acceptance, are depicted in Table 2 for each referral category. Appropriate treatment recommendations for all categories were based on JNC VI recommendations. A recommended follow-up appointment of 4 to 8 weeks with the referring physician was suggested when any adjustment to or initiation of therapy was recommended.[13] When therapy was delayed, follow-up was left to the discretion of the referring physician. All patients were encouraged to adhere to appropriate lifestyle modifications, regardless of their blood pressure level.

Discussion

Isolated office hypertension has been the most common reason for evaluation thus far. Unnecessary intervention was avoided in approximately one third of the patients referred for evaluation of isolated office hypertension. By delaying or minimizing antihypertensive treatment, a 24-hour ABPM

Table 2. Primary 24-Hour Ambulatory Blood Pressure Monitoring Results.

Category	Number Confirmed/ Suspected (%)	Recommendation	Percent of Recommendations Accepted by Physician
Isolated office hypertension	12/40 (30.0)	Delay initiation or addition to hypertension therapy	100
Resistant hypertension	1/8 (12.5)	Add to present therapy	100
Orthostatic hypotension	1/1 (100.0)	Patient education about orthostatic hypotension	100
Type 2 diabetes	6/7 (85.7)	Titrate angiotensin-converting enzyme inhibitor or add low-dose thiazide diuretic	100

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consultation service was effective in relieving some of the costs related to drug acquisition, therapeutic monitoring, and potential drug-induced adverse events. Such monitoring might also further ensure compliance by avoiding polypharmacy and unnecessary therapy.

Twenty-four-hour ABPM was beneficial for the evaluation of blood pressure in patients with type 2 diabetes mellitus. Not only are patients with diabetes twice as likely to have hypertension, it has been suggested that 30% to 75% of diabetes complications are correlated with hypertension.[16] The importance of controlling blood pressure in this population, along with the more stringent goals of therapy, made 24-hour ABPM very useful when caring for diabetic patients. The critical blood pressure load threshold needed to produce target organ damage in the diabetic population is currently unknown. It is theorized, however, that this threshold might be considerably lower than the 40% threshold reported for the nondiabetic population.[8] In at least one study, blood pressure control guided by 24-hour ABPM has been shown to decrease proteinuria in patients with type 1 and 2 diabetes treated with the ACE inhibitor trandolapril.[17]

Advantages of 24-hour ABPM include the ability to assess drug-induced alterations in blood pressure, such as suspected orthostatic changes, and to evaluate suspected resistant hypertension. Although resistant hypertension was not confirmed in most suspected cases, some patients were subsequently found to warrant more aggressive pharmacologic intervention. Pharmacists recommended treatment for all study patients, and all the pharmacists' recommendations were accepted by the referring physicians.

There are some limitations of the 24-hour ABPM profile interpretation. The most common limitation involves poor documentation by the patients in their activity diary. Essential elements of the activity diary include notation of wake and sleep patterns, physical activity, and drug-administration schedules. To resolve these problems, the activity diary was revised. The new activity diaries include specific areas for patients to record the times they go to sleep, wake up, are involved in physical activities, and take their medications. This revision has also helped as a compliance reminder. Patients who used this updated version completed essential elements much more efficiently. A diagram for proper cuff placement is also included on the diary because some patients forgot how to reposition the monitors after temporarily removing them.

As with any new service, lack of monetary reimbursement could be a primary obstacle for initiating a 24-hour ABPM service. This service is ongoing, and long-term outcomes assessment is underway. The goal of such evaluation is to provide information regarding the cost-benefit ratio of ABPM. Eventual reimbursement will likely be available through managed care organizations in an effort to reduce overall health care costs.

Conclusions

This project shows the feasibility of a 24-hour ABPM service in an ambulatory care environment. Such a service was successfully implemented and accepted by both patients and physicians. In this study the service was used to confirm isolated office hypertension, to determine modification of drug therapy for patients with diabetes, to rule out suspected resistant hypertension, and to determine whether patients had drug-induced alterations in blood pressure. Although expert panels recommend that ABPM be used with select patient populations, widespread use of ABPM will likely follow data showing improved patient outcomes.

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