

THE MEDICAL TECHNOLOGY FORUM

A SUMMARY OF THE WORKSHOP REPORT ON:

**FULLY AUTOMATED AMBULATORY BLOOD PRESSURE MONITORING
CURRENT AND FUTURE APPLICATIONS**

National Academy of Sciences
Washington, D.C.
March 5, 1986

Medical Technology and Practice Patterns Institute
2233 Wisconsin Avenue, N.W., Suite 302
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March 5, 1986
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Survey
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The workshop panel members were:

John C. Rose, M.D., (Chair), Harriet P. Dustan, M.D., and Steven J. Jay, M.D.

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FULLY AUTOMATED AMBULATORY BLOOD PRESSURE MONITORING

National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C.

March 5, 1986

AGENDA

8:15 a.m.	Welcome & Workshop Objectives,	S. Perry, Moderator
8:15	CLINICAL EXPERIENCE WITH FAABPM AT: New York Medical Center,	T. Pickering
	Discussion	
8:40	University of Pittsburg Hospital,	A. Shapiro
	Discussion	
9:05	VA Medical Center, Long Beach,	M. Weber
	Discussion	
9:30	Medical College of Georgia,	A. Carr
	Discussion	
9:55	George Washington Univ. Hospital,	B. Garrett
	Discussion	
10:35	Comparison among ECHO, FAABPM and Casual BP measurements,	R. Devereux
	Discussion	
11:00	National Center for Health Statistics/HANES III, activities related to hypertension and FAABPM,	D. Savage
11:25	AAMI FAABPM standards activities,	V. McCall
11:40	General Discussion	

1:30 p.m.	National High Blood Pressure Education Program Coordinating Committee and American College of Cardiology FAABPM Policy Activities,	E. Frohlich
2:00	NHLBI/FAABPM research activities, Discussion	G. Payne
2:15	Open panel discussion,	H. Dustan, S. Jay, J. Rose
	Proposed patient selection criteria for use of FAABPM in diagnosis of the suspected borderline hypertensive patient Discussion	
2:30	Proposed patient selection criteria for use of FAABPM in management of the suspected non-compliance patient Discussion	
2:40	Proposed patient selection criteria for use of FAABPM in management of therapy Discussion	
3:00	Development of Workshop Recommendations	
4:30	Adjournment	

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Foreword

NATIONAL HEALTH SERVICES AND PRACTICE PATTERNS SURVEY (NHSPPS)

DESCRIPTION

The National Health Services and Practice Patterns Survey (NHSPPS) is a unique data monitoring and analysis system that is dedicated to providing hospital administrators with insight into resource consumption and utilization patterns of new technology. The program surveys and analyzes data in a way that individual hospital experience can be understood when compared with a national average hospital industry profile.

Hospitals participating in the Prospective Payment System (PPS) have had to become more cost conscious in order to survive this new competitive environment. One means of maintaining a competitive edge is through the use of new and innovative technologies. However, decisions by hospital administrators to adopt new technology are often marked by uncertainty of third party payment and by disparity between true costs and reimbursement levels. The ability of government agencies to inform themselves accurately and on a timely basis about cost and utilization patterns is essential in ensuring appropriate and timely decisions. Payment policy decisions based on incomplete cost and utilization information may favor certain new treatments or services over others and may often result in underpaying certain hospitals for providing new services. The National Health Services and Practice Patterns Survey was created to fill this information gap and help to avoid payment inequities of PPS and other third party payment programs.

BENEFITS TO NHSPPS PARTICIPATING HOSPITALS

Information resulting from the National Health Services and Practice Patterns Survey is vitally important to hospitals for the following reasons:

- o Semi-annual reports provide a convenient management tool for integrating technological progress into the strategic planning, identifying departments (or cost centers) in need of productivity and resource consumption improvements, projecting utilization rates, and measuring productivity in relation to the national average hospital industry information, and for aiding in the assessment of the impact of new technologies for cost and management structures,

- o Data, collected and aggregated from participating hospitals create useful mechanism that has influenced policy makers reimbursement decisions for new technologies,
- o Participating hospitals reduce their financial risk in acquiring new technology by decreasing the lag-time between third party payer decisions to cover a new technology and decisions to set appropriate reimbursement levels (e.g. appropriate DRG assignment) for new technology, and
- o Specific studies enable a detailed demonstration of the impact of various reimbursement policy options for individual hospitals and the hospital industry as a whole.

CURRENT NHPSPS ACTIVITIES

Current technologies under study by the National Hospital Service and Practice Patterns Survey include:

- | | |
|--|--|
| o Magnetic Resonance Imaging | o Percutaneous Lithotripsy |
| o Extracorporeal Shockwave Lithotripsy | o Heart Transplantation |
| o Endocardial Electrical Stimulation | o Ambulatory Blood Pressure Monitoring |

PROCESS

The National Health Services and Practice Patterns Survey process includes the systematic collection and analysis by the Institute for Health Policy Analysis of information from participating hospitals. The process includes:

- o Collection and analyses of hospital cost and utilization information;
- o Solicitation of judgments by participating hospitals regarding appropriate applications and costs of new technology;
- o Development of reports on the study findings and distribution to participating hospitals; and

- o Submission of National Health Services and Practice Patterns Survey results to appropriate government agencies for their consideration of appropriate DRG assignment and payment. Anonymity of individual hospital information is maintained in all NHSPPS studies.

Each project monitors a specific emerging technology over a three to four year period during its early phase of diffusion. In this way, experience and important trends are discovered and examined. Individual projects terminate when there is general agreement among providers regarding third party payment policy for a specific technology.

GOALS

Medicare's Prospective Payment System (PPS) and other third party reimbursement policy should neither inhibit nor inappropriately encourage growth of new technology. The objective of the National Health Services and Practice Patterns Survey is to provide information to hospital administrators and policymakers that will result in appropriate payments for these services, thus avoiding financial barriers to access to new technology by all categories of patients. Thus, the availability of accurate and complete cost information is critical to this policy decision making process. It is our hope that decisions based on survey information will encourage adoption and use of appropriate new technology, hospital productivity, long-term cost effectiveness, and financial stability for hospitals, patients and third party payers.

FUNDING

The National Health Services and Practice Patterns Survey is funded by hospitals participating in survey activities.

This report summarizes the presentations, debate and discussion of the workshop on, "Fully Automated Ambulatory Blood Pressure Monitoring." Specific references for the information presented in this workshop summary may be obtained by writing the National Health Services and Practice Patterns Survey, c/o Institute for Health Policy Analysis, 2121 Wisconsin Avenue, N.W., Suite 220, Washington, D.C. 20007.

Dennis J. Cotter
Director
National Health Services
and Practice Patterns
Survey

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PART I: WORKSHOP PANEL RECOMMENDATIONS

A. CURRENT ACCEPTED DIAGNOSTIC APPLICATIONS

The panel strongly endorses use of FAABPM as a standard accepted diagnostic practice for the following indication:

FAABPM readings should be obtained when there is discordance between home BP readings and those obtained in the doctor's office or clinic. FAABPM information is important, particularly if the discrepancy between home and office/clinic readings would result in an inappropriate (re)classification of patients into a more or less severe hypertensive category or into a normotensive category, and if the (re)classification and subsequent therapy were to be based exclusively on either home or office/clinic measurements. FAABPM information is particularly important when this discrepancy occurs and there is no known risk factor for hypertension or there is no apparent target organ involvement.

B. POTENTIAL PATIENT MANAGEMENT APPLICATIONS

The panel notes that use of FAABPM in patient management shows great promise as an aid to refinement of therapy. The following management applications appear to be diffusing rapidly in the medical community:

1. BP management in the compliant patient that appears uncontrolled despite introduction of additional antihypertensive agents;

2. patients with borderline hypertension whose home pressures are not elevated;
3. patients with histories suggestive of episodes of syncope or orthostatic hypotension who have had Holter monitoring and for whom there is a need of further diagnostic information;
4. patients with symptoms or signs suggesting episodic hypertension (e.g. pheochromocytoma);
5. patients with episodic or nocturnal angina pectoris unrelated to exertion;
6. patients thought to be adequately controlled in serial office visits using AHA standards of blood pressure measurement but with evidence of progression of target organ (end organ) damage (e.g., progressive echocardiographic left ventricular hypertrophy, myocardial infarction, cerebrovascular event, congestive heart failure, claudication) and adequate control of other risk factors (e.g., smoking, cholesterol); and
7. newly discovered hypertensive patients less than 50 years of age with casual office diastolic blood pressures in the mild category (90-94 mmHg or 90-104 mmHg) with no evidence of target organ (end organ) damage, such as:
 - o left ventricular hypertrophy by physical examination;
 - o ECG-LVH, ECG ischemia, old myocardial infarction;

- o congestive heart failure; or
- o cerebrovascular event of TIA or stroke or renal dysfunction (serum creatinine greater than 1.4 mg/DL or proteinuria consistently greater than 2+) and there is a need to determine whether antihypertensive drug therapy should be initiated.

C. RESEARCH IMPLICATIONS OF FAABPM RELATED TO FURTHER CHARACTERIZATION OF HYPERTENSION IN THE U.S.

There are several ways in which FAABPM technology can be of value in a clinical setting. FAABPM is primarily used as a diagnostic aid and secondarily as a means for assessing patient management. However, the use of FAABPM in assessing patient management (i.e., treatment responses) is still somewhat speculative as an accepted practice, and standards and criteria are yet to be well established.

The panel strongly recommends that this technique be applied to broad research issues in patient management of hypertension. An obvious use in this context is to determine the efficacy and duration of action of new antihypertensive drugs or other modalities of treatment. Large-scale studies of an epidemiological nature correlating blood pressures with other cardiovascular parameters clearly would be enhanced by this technology. Studies of the natural history and clinical characteristics of hypertension would also be appropriate uses of this technique. Finally, we recommend that research into

the technology itself be continued. Such research should involve not only the development of instrumentation, but also evaluations of the clinical techniques and methods that optimize its practicality and accuracy.

FAABPM is viewed as a useful epidemiologic tool that will help refine the definition of hypertension. FAABPM should be used in the National Center for Health Statistics/NHANES III for this purpose. FAABPM information would be useful in the following areas:

- o a comparative study of the sensitivity, specificity and predictive accuracy of home versus office BP in relation to determining the predictability of cardiovascular disease and the need to modify management of hypertension;
- o a study to establish "normal" 24 hour BP mean values; and
- o a study of normotensive patients to determine the means and frequency of pressor events.

D. CLINICAL INVESTIGATION RELATED TO DEMONSTRATION OF DRUG EFFICACY

Recent data presented to the Food and Drug Administration concerning duration of drug efficacy have been based on 24-hour blood pressure monitoring, and have been accepted by the FDA as an excellent basis for such submissions.

FAABPM information is a useful tool for purposes of demonstrating efficacy of investigational antihypertensive

agents particularly the dose response characteristics of these agents over a 24-hour period.

E. CLINICAL RESEARCH RELATED TO DEVELOPMENT OF NEW THERAPEUTIC APPROACHES TOWARD TREATMENT OF HYPERTENSION

FAABPM is recognized as a useful diagnostic tool that may serve as a guide to both researchers and clinicians in further improvement of therapeutic practice. Use of FAABPM in combination with other technologies should be included as a measure of efficacy for new approaches toward treatment of hypertensive patient population.

F. RESEARCH RELATED TO FURTHER DEVELOPMENT OF FAABPM TECHNOLOGY

FAABPM data may be affected by excessive body fat and arm and body motion. Application of FAABPM to patients who are highly active or morbidly obese remains inappropriate. Further development of FAABPM technology is needed in these areas.

PART II: HYPERTENSION: QUESTIONS OF PREVALENCE, DIAGNOSIS,
AND MANAGEMENT

A. INTRODUCTION

In this new environment of cost-containment, prospective third-party payments and more price-sensitive purchasers, greater effort has been directed toward assessing the resource utilization patterns, benefits and cost-effectiveness of disease management. Not only newly introduced medical devices and drugs are being subjected to this scrutiny; older conventional diagnostic and therapeutic methods are being reevaluated as well with a more critical examination of costs and expected gains. It is also likely that the application of new technologies will be directed increasingly toward enhancing the efficiency of health care delivery and refining established clinical tools for greater utility. The management of hypertension is a prominent subject for assessment and public policy concern because of its prevalence among the general population and its significant demands upon health care resources.

In the past decade, the use of antihypertensive drugs to prevent cardiovascular morbidity and mortality has greatly expanded.¹ In the United States, an estimated 57.7 million individuals either have had an office blood pressure reading of 140/90 or greater or have been labeled as hypertensive by a physician.³ Of this number, 76.4%, or a total of about 44 million persons, have been estimated to have a diastolic blood

pressure (DBP) level measured between 90-105 mmHg or a systolic blood pressure (SBP) between 140-160 mmHg.³ It is this population with mild hypertension that has been targeted increasingly for intervention by the public health and medical communities.

The social consequences of this effort for disease prevention have been considerable. In 1980 the treatment of hypertension was the leading indication for physician visits⁴ and, in 1982, it accounted for the largest number of prescription drugs dispensed.⁵ More patients, an 88.6% share, received at least one prescription for this condition than for any other chronic condition.⁶ A conservative estimate of the costs of drugs alone in treating these 40 million mild hypertensives easily could total between \$7 and \$10 billion a year. Costs including office visits and ancillary tests and services could raise this total to a minimum of \$20 billion a year.⁷ Moreover, concerns about the side effects of drug treatment, poor compliance patterns, and the psychological impact of "labeling" patients as hypertensive, as reflected by an increase in absenteeism from work and a decrease in their sense of well-being, have contributed to the controversy.

The value of treating patients with moderate to severe hypertension has been established with certainty.⁸ Many have justified the expansion of clinical indications to include persons with diastolic blood pressure readings of 90 mmHg or higher, and have pointed out benefits in preventing progression

to end organ damage and in reducing deaths from cardiovascular and coronary heart disease.^{9,10} Others have challenged the universality of this approach, citing that only a small fraction of those patients labeled as mild hypertensives would benefit from therapy, and some may be inappropriately treated without consideration of additional factors such as the presence of other cardiovascular disease.^{11,12} In this report, the prevalence and the risks associated with mild hypertension, and the degree of protection conferred by conventional management will be discussed, and evidence will be reviewed regarding the role of fully automated ambulatory blood pressure monitoring (FAABPM) in the diagnosis and management of hypertensive therapy.

B. CURRENT DEFINITION OF MILD HYPERTENSION

The Joint National Committee's (JNC) Third Report on Detection, Evaluation and Treatment of High Blood Pressure⁶⁰ defined a hypertensive patient as one exhibiting a systolic pressure in excess of 140 and a diastolic pressure equal to or greater than 90 mmHg. Patients having a diastolic pressure of less than 90 and a systolic pressure between 140 and 159 mmHg are identified as having borderline isolated systolic hypertension. The World Health Organization (WHO) guidelines define a borderline hypertensive patient as one having a diastolic pressure between 90 and 94 mmHg. WHO's borderline hypertension definition also includes patients with systolic BP between 150 and 159 mmHg with normal (less than 90 mmHg)

diastolic BP. Patients whose diastolic BP persistently remains between 85 and 89 mmHg are said to have a high normal BP and the JNC recommends that these persons be followed at yearly intervals because of the possibility of developing sustained diastolic hypertension.

C. PREVALENCE OF MILD HYPERTENSION

Estimates of the prevalence of hypertension depend upon the definition and qualifying criteria used. The blood pressure level as measured in the physician's office or clinic has generally served as a guide to categorizing patients as normotensive or hypertensive and to initiating and adjusting the treatment regimen. However, a number of studies¹³⁻¹⁶ have questioned the reliability of the office blood pressure alone in guiding appropriate clinical management for all patients.

The present estimates of hypertension prevalence by the National Health and Nutrition Examination Survey are based on a single-occasion blood-pressure reading of a diastolic blood pressure (DBP) above 90 mmHg or current reported use of antihypertensive medication. On the second or third occasion of blood pressure measurement, the number of patients considered eligible for treatment would be expected to drop. An exact number of cases is not known, but observations from various large clinical trials indicate a significant attrition after initial screening or after a short-term follow-up period. In the Hypertension Detection and Follow-Up Program,

37.4% of those patients with an initial DBP reading above 95 mmHg had a second measurement below 90 mmHg.¹⁷ In the Australian Therapeutic Trial in Mild Hypertension, the mean blood pressure fell from 158/102 to 144/91 in the control study population which was on placebo; this effect was not influenced by variables of age or cardiovascular risk factors. 48% of those subjects labeled as mild hypertensive who were randomized to receive placebo had a DBP below 95 mmHg 3 years later.¹⁸ Annual clinic DBP measurements taken during the Medical Research Trial showed that 1/3 to 1/2 of placebo subjects had a DBP of less than 90 mmHg.¹⁹

Several investigators have examined the use of automated ambulatory blood pressure monitoring in assessing patients with elevated office blood pressure readings. Sokolow and Perloff²⁰ observed that in 174 patients with office diastolic pressures of 95-104 mmHg, 63% of treated and untreated patients had ambulatory BP readings of less than 95 mmHg. In a study of 150 patients with DBP greater than 90 mmHg on 3 office visits, McCall and McCall¹⁵ reported that 39% were found to have fairly normal ambulatory BP values, with less than 10% of readings taken over the course of 24 hours measuring higher than 90 mmHg. From a series of 245 patients labeled hypertensive based on repeated BP readings in a physician's office, 56% were found to have a mean ambulatory DBP of less than 90 mmHg by Waeber et al.²¹ Comparing physicians' cuff readings, automatic recorder readings and intraarterial recordings in 36 elderly patients, Hla et al¹⁶ found that the mean physician's

cuff DBP was more than 10 mmHg greater than the intraarterial value in 40% of patients, and that the automatic recorder values were more than 10 mmHg higher in 8.3% of patients.

Clearly, either multiple or more accurate diagnostic measurements are required for patients initially suspected of being mildly hypertensive before therapy is initiated. Mislabeling of a patient could not only expose him/her to unnecessary risks of drug therapy and entail added expenditures for management, but could also produce possible adverse consequences for his/her sense of well-being and perception of health.²²

D. RISKS ASSOCIATED WITH MILD HYPERTENSION

Risks of morbidity and mortality have been shown to increase substantially when DBP rises above 85-90 mmHg, using office blood pressure measurements as criteria.²³ But this relationship does not necessarily prove a uniformity of risk exists for persons with the same measured blood pressure level or that risks can be universally avoided by treatment aimed at lowering blood pressures below this level. The population of patients labeled as mild hypertensives appears to be heterogenous and includes many patients facing relatively low risks of cardiovascular morbidity and mortality.

In the Framingham Study, the five-year survival rate for patients less than 75 years old with blood pressures measured in the range of 90-94 mmHg was 85% or above.²⁴ Other studies have reported that for selected patient subsets, five-year

survival rates even for untreated mild hypertensive patients were 97% or better.²⁵ In one study, prediction of coronary artery disease based on knowledge of risk factors such as blood pressure, smoking and cholesterol levels yielded fairly low accuracy rates for an individual patient without recognized coronary disease: only 7% of those patients categorized as being at high risk actually developed a myocardial infarction in five years time.²⁶ Thus, although casual blood pressures have served as useful predictors of risk, the prognostic value of blood pressure measurements for predicting cardiovascular morbidity of a particular individual may be strengthened by more specific indices of cardiovascular load.

For example, echocardiography (echo) was used to diagnose left ventricular hypertrophy (LVH) in subjects from the Framingham study.²⁷ The preliminary data have indicated that echo results could be used to select mild hypertensives needing intensive medical treatment in early stages of the disease. ECG LVH usually appears later in the course of hypertensive cardiovascular disease, whereas echo LVH may appear early in the course of this disease.²⁷

Also, ambulatory blood pressure levels, obtained by monitoring patients over the normal course of a day's activities, have been shown in some studies to be more significantly correlated with signs of target organ damage¹³ and with incidence of cardiovascular morbidity and mortality than office blood pressure readings.²⁸ This correlation was shown in a series of 100 patients studied by Devereux et

al.²⁹ Ambulatory BP readings and left ventricular mass index (LVMI) of patients were more significantly correlated than casual BP readings and LVMI. Floras et al³⁰ used ambulatory BP monitoring to assess 59 mild hypertensive patients who had similar casual BPs. Patients who had elevation of both casual and ambulatory BP had a 64% prevalence of target organ damage whereas patients with a lower ambulatory BP (ABP) had a 19% incidence of damage. In the follow-up of 1,076 patients, Perloff et al. found that in groups with comparable office BPs, the ambulatory BP value was more predictive of the ten-year incidence of fatal and nonfatal cardiovascular events.²⁸

E. BENEFITS OF CURRENT TREATMENT

The Cooperative Veteran's Administration clinical trials clearly demonstrated that drug treatment improved outcome for patients with severe and moderate hypertension.⁸ However, the assumption that this benefit would also extend to the mild hypertensive population has not been proven conclusively (particularly for coronary heart disease end points) in recent clinical trials.

The principal study contributing to the impetus to treat mild hypertension was the Hypertension Detection and Follow-up Program (HDFP) in the United States. One of its major findings was that, for mild hypertensive patients (DBP 90-104 mmHg), cardiovascular mortality and total mortality were lower in the stepped-care group than in the control or referred-care groups.¹⁷ For the subgroups of white women and persons aged

30-48 years, no statistically significant reduction in mortality was found. The incidences of stroke and myocardial infarction were reduced in the stepped-care group. It is possible that the improvement could be attributed partially to superior vigilance and follow-up care in the stepped-care group. The rate of five-year mortality from all causes was 5.9/100 in the stepped-care group compared to 7.4/100 for patients in the referred-care group. This difference suggests that stepped care may result in preventing or postponing 1.5 deaths per 100 patients treated.

The Multiple Risk Factor Intervention Trial (MRFIT) did not demonstrate a significant reduction in the rate of coronary mortality in the special intervention group as compared to the usual care group. There may have been a favorable effect on coronary heart disease (CHD) mortality for men with a normal electrocardiogram who received special care. But men who entered the trial with an abnormal ECG and received special intervention had a higher mortality rate than the control subjects.³¹ It is possible that the use of drug therapy was associated with the increased CHD mortality in this subset.³¹

In the Australian Therapeutic Trial in Mild Hypertension, the benefits of treatment were clearly demonstrated for patients with an entry DBP greater than 100 mmHg. However, in patients with DBP less than 100 mmHg, treatment was not always clearly beneficial. In fact, at blood pressure levels below 100 mmHg, morbidity and mortality were higher for patients who received drugs than for patients who received placebo who were

found on the first or subsequent screenings to have an elevated BP reading.³² For patients with average DBP below 100 mmHg, clinic BP levels were not found to be significantly associated with the occurrence of cardiovascular events.¹⁸ The Oslo study found that antihypertensive therapy had no significant effect on cardiovascular morbidity and mortality in men aged 50 years or less.³³

The Medical Research Council (MRC) trial of treatment of mild hypertension in Britain showed the following results. The incidence of stroke was significantly reduced for patients who received active treatment, but treatment made no difference in overall rates of coronary events or all-cause mortality. More than 95% of the control patients did not develop any cardiovascular complications during the trial. The researchers concluded that, if 850 mild hypertensive patients were given drug therapy for one year, one stroke would be prevented.¹⁹

In these trials, important but infrequent benefits have been shown in the prevention of morbidity and mortality. One analysis which considered the results from the Australian, Oslo, HDFP and MRFIT trials, indicates that treatment with drug therapy for 3-7 years averts one death from all causes per 156 persons and one coronary death per 455 persons treated.¹ This could add up to a substantial benefit in the aggregate. The increase in early diagnosis and treatment of hypertension has been credited for contributing to the recent decline in cardiovascular mortality rates.³⁴ The extent to which hypertension control is responsible for reduced coronary heart

disease mortality is not clear, because of the multiple risk factors involved and data showing greatest mortality declines in groups with lower rates of hypertension control.³⁵

Balanced against these gains in survival are the effects of drug therapy on quality of life. In the MRC trial, 15-20% of patients withdrew because of intolerable side effects.¹⁹ Adverse drug reactions include impaired glucose tolerance, gout, impotence, fatigue, orthostatic hypotension, electrolyte abnormalities and effects upon lipid metabolism. In addition, overly aggressive treatment in a patient, especially in an elderly patient, could lead to compromised blood flow to vital organs, induce unconsciousness,³⁶ decrease mental capacities³⁷ or, perhaps, even precipitate a stroke or myocardial infarction.³⁸

Some studies also suggest that a role exists for ambulatory BP monitoring in evaluating drug treatment response. Gould et al³⁹ found that antihypertensive medication reduced ambulatory BP more than office BP, and that placebo pills affected office BP, but not ambulatory BP. In verifying physician assessment of treatment response, Kennedy et al.⁴⁰ evaluated 14 patients thought to be uncontrolled on medication. Nine of the 14 patients had less than 50% elevated ambulatory BP readings.

In a controlled antihypertensive drug trial comparing timolol and methyldopa, blood pressure response was assessed in a study of 30 patients with mild hypertension.⁴¹ According to the office BP value, the effects of both agents were

similar, and the degree of BP control during the day could not be predicted. The ambulatory BP readings however indicated that timolol was more effective than methyldopa in reducing DBP. In a double-blind clinical trial conducted by Berglund et al.,⁴² 31 hypertensive patients received either placebo or pafenolol. The 24-hour BP readings demonstrated a dose-response relationship of BP to pafenolol, a finding not revealed in the analysis of the casual BP readings.

The study of individuals labeled as mild hypertensives reveals a heterogenous patient population, with an uneven distribution of risks. Therapeutic approaches based solely on screening blood pressure levels would require the long-term and perhaps even life-long treatment of a large population of patients who, on-the-average, probably face relatively low risks of complications and mortality in order to benefit a small fraction of that population. The ultimate goal should be to devise a treatment strategy that will identify patients at highest risk in order to maximize benefit to them and spare any unnecessary or inappropriate intervention to patients at minimal risk.

F. SOCIAL CONSEQUENCES

From a societal and ethical perspective, questions have arisen concerning the use of casual blood pressure measurements in community hypertension screening programs.²² In many cases, multistage screening and follow-up programs are not feasible or practical, and the results of labeling patients as

hypertensive may have adverse psychological and behavioral effects. Many patients newly labeled as hypertensives, even if at minimal risk for developing disease sequelae, may come to perceive themselves as ill, alter assessments of their health status, and more readily attribute subjective symptoms to organic illness.

In a study of 208 patients, a threefold increase in absenteeism from work was observed in patients who were newly labeled hypertensive, whether or not drug therapy was instituted or BP control was achieved.⁴³ In a longer-term follow-up of these subjects, the higher level of absenteeism persisted for at least four years.⁴⁴ Another study of a worksite population showed that only young subjects and subjects with systolic hypertension had increases in absenteeism, and that those subjects newly labeled and actively followed but not treated experienced a more pronounced increase in absenteeism.⁴⁵

Another analysis identified a group of 71 individuals who were previously labeled as hypertensive, but, upon further measurements for validation of the diagnosis, were found to be normotensive. This mislabeled group reported significantly more depressive symptoms and a poorer rating of health status than a matched control group.²² These results indicate that suspected illness judgments made by providers can evoke a process that results in measurable changes in the perceptions and definitions of an individual's own health.

G. COSTS

The costs of placing all labeled mild hypertensive patients on long-term or lifelong drug treatment programs would be significant. Of the approximately 40 million mild hypertensives, perhaps as many as 88.6% would receive at least one drug prescription per year.⁶ Pharmaceutical costs alone per year for treatment with one of the major antihypertensive agents range from about \$175 to \$250.⁴⁶ In addition, there would be direct costs of physician services, other health professional fees and costs of laboratory tests. Using an estimate of \$500-\$600 for the management of one patient, the costs of maintaining all of the patients in the eligible population defined above, on treatment would total between \$18-\$21 billion annually. If the criterion were based on 2 or 3 blood pressure readings, then an estimated 37% of the patients would subsequently be found to have normal BP levels,¹⁷ and the total costs would decrease to between \$12.6 and \$15 billion each year.

H. NEED FOR THE FAABPM WORKSHOP

Hypertension is a significant risk factor for cardiovascular morbidity and mortality. Effective pharmacological agents are available for control of high blood pressure, and results indicate that early diagnosis and drug treatment of a patient at risk for developing target-organ damage are beneficial for preventing subsequent complications. However, the annual risk to an individual patient is relatively

low, and the costs for any adverse drug reactions, overly aggressive treatment, or mislabeling of patients are not negligible.

Blood pressure readings obtained in the doctor's office or clinic are not always considered reliable and repeated measurements are indicated as part of a complete diagnostic evaluation. When there is a significant discrepancy between office and home BP readings, such that a patient could be (re)classified into a more or less severe hypertensive category or in a normotensive category, additional diagnostic testing is generally indicated. Therefore, there is a need to correctly identify those patients who will truly benefit from the administration of drug treatment. The investment necessary to apply an across-the-board treatment strategy to all persons found to have an elevated BP reading would be considerable. Thus, efforts should be aimed at better characterization of this heterogenous population labeled as hypertensive. For example, patients at significant risk for developing hypertension-related morbidity should be differentiated from those at minimal-to-no risk.

From a public policy perspective, questions of prevalence, diagnosis, and management of hypertension in relation to the introduction of new technology such as fully automated ambulatory blood pressure monitoring, raise important issues of diffusion and application of new technology. In response to both public and private interests, the Institute for Health Policy Analysis convened a workshop of leading clinicians and

representatives of both public and private agencies to determine the appropriateness of current use of fully automated ambulatory blood pressure monitoring.

I. WORKSHOP PANEL PROCESS

A panel of three physicians, selected for their broad expertise and knowledge in the areas of clinical medicine and health policy, deliberated on the speaker presentations and discussions at the workshop, and reviewed the available evidence on the utility and effectiveness of FAABPM. During roundtable discussions, the panel members conducted an inquiry of the participants in order to ascertain more precisely areas of consensus and of disagreement regarding the use of FAABPM.

Specifically, the panel focused on addressing the questions of current, state-of-the-art application of FAABPM devices for use in establishing the presence or absence of hypertension in borderline cases and in evaluating and refining drug treatment regimens. At the conclusion of the workshop, the panel met in executive session to develop recommendations for the appropriate use of FAABPM devices for the diagnosis and treatment of hypertension, reflecting a consensus which was apparent at the workshop.

PART III: WORKSHOP PANEL DISCUSSIONS

A. DIAGNOSIS

1. "Is FAABPM useful in establishing the presence or absence of hypertension in difficult to diagnose borderline cases?"

Evidence reviewed by the panel:

Workshop speakers made a strong case for use of FAABPM for this application, based on two lines of evidence: (1) office BP measurements may not be representative of the BP at other times or, the long-term load placed on the circulation and (2) FAABPM measurements correlated more strongly than office BP with evidence of target organ damage and the incidence of morbid events.

According to Pickering,¹³ the rationale for the use of FAABPM is the widely observed variability in blood pressure levels throughout the day. He argued that FAABPM information, consisting of multiple measurements recorded over the course of a 24-hour day, was considered more representative of the patient's cardiovascular load and more predictive of hypertension-related morbidity than single, isolated measurements.

Carr, Weber and Pickering cited the Australian Therapeutic Trial in Mild Hypertension,⁴⁸ which included a total of 1,943 subjects. The trial results showed that untreated subjects, with a diagnosis of mild hypertension based on BP readings taken during 2 office visits, had an

average fall in both systolic and diastolic pressures from 158/102 to 144/91 over a period of 3 years. This occurrence was independent of sex, age, family history of hypertension or stroke, smoking, or serum cholesterol levels. Explanations given for the observed decrease in BP were the patient's adaptation to the method of BP measurement and the phenomenon of regression to the mean. This observation was considered illustrative of the need for repeated evaluation of suspected mild hypertensives before beginning drug therapy. At the end of 3 years, one third to nearly one half of the control subjects who had been diagnosed as hypertensive (diastolic BP from 95-109mmHg) and who were untreated, appeared to be misclassified and were actually normotensive.

Pickering related that, in a study of 270 untreated patients labeled as hypertensive, the average ambulatory BP was found to be 132/90 mmHg or less over a 24 hour time period. One fourth of the patients who had an elevated BP in the clinic were found to be normotensive, based on 24 hour FAABPM measurements.

Savage presented an overview of the epidemiology of the hypertensive patient population and results of the National Health and Nutrition Examination Study II (NHANES). The most recent prevalence estimates of hypertension are 38% for black adults and 29% for white adults, based on the current definition of high blood pressure as greater than 140/90 mmHg. This would total

about 60 million hypertensives in the entire population. These data also indicate that more than 50% of hypertensive adults were aware of their condition, but only 11% had their hypertension under control.

Savage then posed the following questions:

- o Given this large and heterogenous population of mainly mild hypertensives, should echocardiography (echo) and ambulatory blood pressure monitoring be used to stratify mild hypertensives into low-risk and high-risk groups, identifying those patients in need of intensive medical treatment?
- o Would these be useful measurements in the NHANES III study for correlation with future health status?

Weber noted that in a study of normotensive and hypertensive men, 24-hour ambulatory blood pressure monitoring revealed considerable overlap between the two groups. He also suggested that the determination of normal BPs may be aided by using ambulatory BP monitoring techniques.⁴⁹

Savage presented the hypothesis that LVH as measured by echo LVMI (left ventricular mass index) was a new, important, independent risk factor for cardiovascular morbidity and mortality. His hypothesis was based on preliminary results of follow-up studies from the Framingham population⁴⁹ and Cornell Medical Center.⁵⁰

Devereux addressed the prognostic significance of ECHO LVMI, citing a study of 140 men in which echocardiographic evidence of LVH identified patients at high risk for cardiovascular morbidity.⁵⁰ He also presented results of various studies,^{29,51,52} which demonstrated stronger correlation of 24-hour BP levels with LVMI than that of casual BP levels with LVMI (Table 1). In Devereux's study of 100 subjects, higher correlations were found between the ambulatory BP and LVMI ($r=0.50$) than between the casual BP and LVMI ($r=0.24$) or between home BP and LVMI ($r=0.31$). The work diastolic BP held the closest relationship to LVMI ($r=0.59$).²⁹

Table 1.

Correlation of casual SBP and 24 hour SBP with ECHO-LVMI

<u>Principal Investigator</u>	<u>N</u>	<u>Casual SBP</u>		<u>24-hour SBP</u>	
		<u>r</u>	<u>r²</u>	<u>r</u>	<u>r²</u>
Rowlands (1982)	50	0.45	0.20	0.60	0.36
Drayer (1983)	12	0.55	0.30	0.81	0.66
Devereux (1983)	100	0.26	0.07	0.50	0.25

Another study, conducted by Mann,⁵³ compared the 24-hour ambulatory BP reading to the casual BP reading to explain the 10-30% variance in casual BP readings used to predict end-organ damage.⁵³ Pessina et al. studied the target organ involvement of hypertensive patients in relation to casual and automatic blood pressures, with

results indicating that ambulatory BPs were more closely related to organ involvement than casual BPs.⁵⁴

Pickering proposed that FAABPM measurements have value as an independent prognostic indicator in the overall risk profile of hypertensive patients. He cited the study of 1076 patients who were followed for 5 years by Perloff et al..²⁸ Results of that study showed that ambulatory BP information was useful in discriminating between high and low risk patients within a group of patients who were mildly hypertensive (clinic DBP less than 105 mmHg), less than 50 years old and without prior cardiovascular events. In this group of patients with borderline hypertension and no other apparent risk factors or history of cardiovascular disease, additional information such as the FAABPM would be useful in determining diagnoses and in assessing risks.

Carr presented evidence which supported the significance of ambulatory BP values in predicting target organ damage. Carr stated that left ventricular hypertrophy (LVH) is a sensitive indicator of hypertension-induced cardiac wall stress. In a study of 55 hypertensive patients without known risk factors, the ambulatory DBP level correlated with left ventricular wall thickness ($r = .63$) more often than the office DBP level ($r = .33$). The patients with a 24-hour average ambulatory DBP of 88-90 mmHg or higher were more likely to have evidence of LVH than patients with an average ambulatory DBP of less than 88 mmHg. The office diastolic blood

pressures were less than 90 mmHg in seven of nineteen (37%) hypertensive patients, less than 95 mmHg in fourteen of nineteen (74%) hypertensive patients, and less than 105 mmHg in sixteen of nineteen (87%) of the hypertensive patients with left ventricular hypertrophy. The sensitivity of association with left ventricular hypertrophy was seventy-two percent when the 24-hour average DBP was 88 mmHg or greater. Carr's study included twenty-eight percent false positives and sixteen percent false negatives with 24-hour average DBP less than 88 mmHg, that is these patients had left ventricular hypertrophy.

The speakers presented various indications for the use of FAABPM in the diagnosis of hypertension. Weber stated that a major indication for use would be the presence of office BP readings which place the patient in the mild hypertensive category (DBP between 90-104 mmHg); the absence of collateral factors such as family history, concurrent risk factors and early cardiovascular changes; and the absence of correlating home blood pressure readings. In addition, Garrett noted that FAABPM could be useful in the diagnosis of borderline patients presenting with BPs alternating above and below 140/90 on multiple visits without medication. If ambulatory BP readings placed patients in the hypertensive category, their need for treatment could be more precisely defined.

2. "How would you define a significant discrepancy between office and home BP, or casual and basal BP?"

Evidence reviewed by the panel:

In 1940, Ayman and Goldshine's study demonstrated that the BP measured by the physician was higher than home BP levels and numerous studies have subsequently confirmed these findings.⁵⁶

Garrett defined this condition as:

- o a patient who has a casual BP greater than 140/90 mmHg only in the medical environment + 1 hour before or after experiencing this environmental response.
- o a patient who has much lower BP (much less than 140/90 mmHg) both at home and in the work environment, and
- o the physician who has high index of suspicion (i.e. questions of false vs. true hypertension).

The Pickering studies illustrated this syndrome. A subgroup of patients with mild hypertension included in a Pickering study exhibited an increase in BP when measured in the presence of a physician. This phenomena was seldom seen in patients with severe hypertension.

Weber found similar results, stating that 25-30% of the patients of his study group who were initially suspected of having hypertension based on office BP readings, were, in fact, diagnosed as normotensive based on FAABPM readings.

Panel findings related to questions #1 & #2:

The panel concluded that the evidence demonstrated that additional diagnostic testing such as FAABPM was indicated when repeated home and office BP measurements

differed significantly. Independent FAABPM measurements are important for providing unbiased alternative measurements when discrepancies exist. Such discrepancies, if uncorrected, could result in inappropriate (re)classification of patients into a more or less severe hypertensive category or normotensive category. The evidence also indicated that FAABPM measurements were useful where persistent elevations of office BP levels continued over many years in patients with no evidence of cardiac enlargement. Such measurements have provided clearer assessments of the level of patient risk and disease involvement resulting from hypertension in these patients.

B. MANAGEMENT OF THERAPEUTIC INTERVENTION

3. "Is it appropriate to use FAABPM in managing therapy?"

Evidence reviewed by the panel:

Studies were presented by Garrett and Shapiro⁶¹⁻⁶⁴ which illustrated the usefulness of FAABPM in evaluating drug treatment. Shapiro et. al. conducted a double blind randomized cross over trial that included 25 patients. The effects of antihypertensive drugs, placebo and relaxation treatments were compared. Blood pressures were obtained by casual measurement at the doctor's office and by FAABPM. Reliable results were obtained on 13 patients. Relaxation therapy was only slightly effective (resulting in a 3-4 mmHg drop) based on doctor's office BP reading, but there

was no BP change based on FAABPM readings. However, for those periods when patients were receiving antihypertensive drug therapy, office BP readings and 24-hour FAABPM readings were significantly lowered.

Likewise, Garrett found similar results when he studied 235 patients referred to him for FAABPM evaluation. Garrett also observed that in some subgroups of patients, FAABPM evaluation could be a critical tool for determining the necessity, effectiveness, optimal dosage and dosage interval of drug treatment and for refining and adjusting treatment plans.

The participants discussed the possibility that in addition to the value of the average BP over 24 hours, the pattern of BP levels provided by FAABPM may also be a factor to consider in determining risk for cardiovascular morbidity. Shapiro studied a series of patients with FAABPM, and observed a sleep phenomenon, or a decrease in BPs while sleeping, which led to his hypothesis that a sleep fall in BP levels ameliorates the overall cardiovascular load from hypertension. In a retrospective study of a small group of elderly patients, Frohlich demonstrated that in those patients with fewer sleep falls of BP levels had higher incidences of post cardiovascular events.

Garrett offered the following clinical questions as an aid in determining a role for FAABPM in patient management

when more conventional methods have not produced definitive results:

For patients receiving no treatment:

- o Is treatment necessary?

For patients receiving treatment (pharmacotherapy):

- o Is it effective?
- o Is the dose correctly timed? (once-daily vs b.i.d.)
- o If therapy is generally effective:
 - a. Should it be continued as is?
 - b. Are there times when it is not effective, such as while at the work place or in a medical environment, etc.?
- o If therapy is not effective, :
 - a. Should it stay the same?
 - b. Should the dosage of medication be reduced/increased?
 - c. Should the number of medications be reduced/increased?
- o For patients who once were on treatment but are now off treatment:
 - a. Should the patient remain off treatment?
 - b. Should the patient resume treatment?

Frohlich reviewed the current literature and summarized his findings in a report he prepared for the American College of Cardiology on Automated 24-Hour Blood Pressure Recording. His report states:

(A)t present, recognizing the cost and the early state of the art with these imprecise definitions, the practicing physician and cardiologist should be concerned as to which clinical circumstances indicate the utility of the 24-hour automatic blood pressure recording device.

The 24-hour portable and automatic blood pressure recording devices may be extremely useful for the individual who has high arterial pressures in the office when the clinical circumstances do not suggest persistent hypertension at home. This might include the patient with no evidence of cardiac enlargement despite persistent office hypertension. A similar and related circumstance is frequently found with the individual with so-called borderline hypertension in the office and who does, in fact, have elevated home pressures. In this regard, a third clinical problem may be encountered by the physician who may be searching for evidence to support his decision to prescribe antihypertensive therapy. Another possible problem may be found with those individuals who remain on antihypertensive therapy but whose office pressures do not substantiate adequate control but home pressures demonstrate adequate control. Under each of these circumstances the data obtained from 24-hour measurements may be exceedingly useful.

Other clinical circumstances might include the patient with hypertension and with a history of syncope or postural hypotension in order to document these events by 24-hour pressure recordings. Similarly, the device may also be particularly useful for patients with history of 'spells' and syncope but who do not have hypertension. The 24-hour recording may be particularly useful to document relationship of blood pressure changes to the symptoms. In this regard, the Holter recorder for 24-hour electrocardiogram may be utilized together with the 24-hour blood pressure recording; and the documentation of cardiac arrhythmias associated with pressure changes would be most important.

With respect to symptomatic episodes, the 24-hour pressure recording may be very useful in evaluating the patient with episodic hypertension (e.g., pheochromocytoma). Similarly, the recording may be of value in relating blood pressure levels to other symptoms that the patient presents (e.g., headache, palpitation, chest discomfort). Related to this may be the need to provide mechanisms for episodic or nocturnal angina pectoris or angina unrelated to exercise. These episodes may be related to cardiac arrhythmias or episodic hypertension or hypotension.*⁵⁷

Panel Findings related to question #3:

The panel concluded that the evidence supported a growing usefulness of FAABPM for patients with the following conditions or for making the following determinations:

- a. a history suggestive of episodes of syncope and orthostatic hypotension, in patients who have had Holter monitoring,
- b. symptomatic episodes suggestive of episodic hypertension (e.g. pheochromocytoma),
- c. episodic or nocturnal angina pectoris unrelated to exertion,
- d. to determine whether use of certain drugs, when taken prior to sleep, excessively lowers BP during sleep; and
- e. to determine whether adequate blood pressure control is achieved with antihypertensive medication over a 24-hour period. (This application of FAABPM has been very useful in clinical investigations which demonstrate the actual efficacy of medications said to be active for a 24-hour duration.)

4. How do you select these cases?

Evidence reviewed by the panel:

Evidence reviewed is cited under question #3.

Panel findings related to question #4:

Based on information cited in response to question #3, the panel was satisfied that question #4 was answered. The panel concluded that the evidence supported a growing usefulness of FAABPM for those patients exhibiting other conditions such as:

- a. a hypertensive patient thought to be adequately controlled in serial office visits using AHA standards of blood pressure measurement with evidence of

progression of target organ (end organ) damage (progressive echocardiographic left ventricular hypertrophy, myocardial infarction, cerebrovascular event, congestive heart failure, claudication) and adequate control of other risk factors (e.g., smoking, hypercholesterolemia);

- b. a newly discovered hypertensive patient less than 50 years of age with casual office diastolic blood pressures in the mild category (90-104 mm Hg and no evidence of target organ (end organ) damage [such as left ventricular hypertrophy by physical examination, ECG-LVH, ECG ischemia, previous myocardial infarction, congestive heart failure, cerebrovascular event of TIA or stroke or renal dysfunction (serum creatinine greater than 1.4 mg/DL or proteinuria consistently greater than 2+)] and there is a need to determine whether antihypertensive drug therapy should be initiated;
- c. a compliant patient who appears uncontrolled despite maximal dosage of 3 or more antihypertensive agents;
- d. a patient exhibiting persistent elevation of office BP levels over many years with no evidence of cardiac enlargement; and
- e. a patient with hypertension and unexplained symptoms associated with signs and symptoms of variable disease and apparent BP control.

5. How does FAABPM supplement home blood pressure measurements in these cases?

Evidence reviewed by the panel: Garrett stated that ambulatory BP measurements can supplement home BP measurements by providing: additional data, reduction of bias on the part of the individual taking the measurement, observer neutral information, and a method of verifying home BP measurements.

Participants discussed the usefulness and limitations of home BP monitoring in the assessment of borderline cases. Weber noted that it can be very useful in confirming the diagnosis when there is agreement with the clinic BP. Home BP monitoring is a less costly alternative to FAABPM and may

correlate slightly better to ambulatory BP than office BP.⁵⁸ However, the accuracy of home blood pressure measurements depends on the equipment and the skills of the user. In addition, Pickering pointed out that there have been no studies demonstrating a prognostic significance of "patient-taken" home BPs measurements related to risks of cardiovascular morbidity and mortality. Weber also remarked that, since there is a normal circadian pattern of blood pressure which includes a decrease in BP levels in the evening and at night time, home BP values used to determine basal BP may not be representative of the average or stressed cardiovascular load, especially as experienced during work.

Additional evidence cited is included in section II above.

Panel findings related to question #5: The evidence supported usefulness of FAABPM as a supplement to home BP measurements when:

- a. a patient exhibits a significant discrepancy between home BP readings and those obtained in the doctor's office or clinic causing a (re)classification of the patient into either a more or less severe hypertensive category or a normotensive category so that there is a need for further diagnostic information;
- b. there is a need to demonstrate 24-hour control of BP;
or
- c. a patient with borderline hypertension has an elevated home BP.

C. FAABPM COSTS

Although the panelists were not asked specifically to consider this topic, workshop speakers estimated that the initial capital costs of an FAABPM system were in the \$10,000

to \$16,000 range (including computer software and one FAABPM unit) and that capital costs for each additional unit would be approximately \$4,000. If amortized over a five year period, the capital cost per unit would be approximately \$275 per month for the first FAABPM unit and \$110 per month for each additional unit. Operating costs such as physician or other medical attendant salaries, overhead, supplies, etc., are not included in this estimate.

REFERENCES

1. Hyman, D.; Kaplan, N.M.: "Treatment of Patients with Mild Hypertension." *Hypertension*, Vol. 7, No. 1, March-April 1985, pp. 165-70
2. Toth, P.J.; Horwitz, R.I.: "Conflicting Clinical Trials and the Uncertainty of Treating Mild Hypertension." *The American Journal of Medicine*, Vol. 75, September 1982, pp. 482-8
3. Final Report of the Working Group on Risk and High Blood Pressure: "An Epidemiological Approach to Describing Risk Associated with Blood Pressure Levels." *Hypertension*, Vol. 7, No. 4, July-August 1985, pp. 641-51
4. Collins, J.G.: "Physician Visits: volume and interval since last visit, United States, 1980. Publ. (PHS) No. 83-1572, Series 10, No. 144, U.S. Dept. of Health and Human Services, 1983
5. Baum, C.; Kennedy, D.L.; et. al.: "Drug Use and Expenditures in 1982." *Journal of the American Medical Association*, Vol. 253, No. 3, January 18, 1985, pp. 382-6
6. Cypress, B.K.: "Medication therapy in office visits for hypertension." *National Ambulatory Medical Care Survey, 1980. Advance data No. 80, National Center for Health Statistics, 1982*
7. Freis, E.D.: "Should Mild Hypertension be Treated?" *New England Journal of Medicine*, Vol. 307, No. 5, July 29, 1982, pp. 306-10
8. Veterans Administration Cooperative Study Group on Antihypertensive Agents. "Effects of treatment on morbidity in hypertension: results in patients with diastolic blood pressures averaging 115 through 129 mmHg. *JAMA*, Vol. 202, 1967, pp. 1028-34
9. Frohlich, E.D.: "Mild hypertension: to treat or not to treat." *J. Am. Coll. Cardiol.*, Vol. 3, No. 2, February 1984, pp. 447-50
10. Moser, M.; Gifford, R.W.: "The case for the treatment of mild hypertension." *Journal of Cardiovascular Pharmacology*, Vol. 7, 1985, pp. 5102-08
11. Aagaard, G.N.: "Hypertension - Indications, Goals and Potential Risks of Drug Therapy." *Western Journal of Medicine*, Vol. 141, No. 4, October 1984, pp. 476-80

REFERENCES (Continued)

Page 2

12. Ram, C.V.: "Should Mild Hypertension be Treated? Choosing the Middle Course." *Medical Clinics of North America*, Vol. 68, No. 2, March 1984, pp. 469-76
13. Pickering, T.G.; Harshfield, G.A.; et. al.: "What is the Role of Ambulatory Blood Pressure Monitoring in the Management of Hypertensive Patients?" *Hypertension*, Vol. 7, No. 2, March-April 1985, pp. 171-7
14. Perloff, D.; Sokolow, M.: "The representative blood pressure: usefulness of office, basal, home, and ambulatory readings." *Cardiovascular Medicine*, Vol. 3, No. 6, June 1978, pp. 655-68
15. McCall, M.C.; McCall, V.R.: "Evaluation of Hypertension by Means of Fully Automated Blood Pressure Monitoring." *Health Care Instrumentation*, Vol. 1, No. 1, 1985, pp. 22-6
16. Hla, K.M.; Vokaty, K.A.; Feussner, J.R.: "Overestimation of Diastolic Blood Pressure in the Elderly: Magnitude of the Problem and a Potential Solution." *Journal of the American Geriatrics Society*, Vol. 33, No. 6, October 1985, pp. 659-64
17. Hypertension Detection and Follow-Up Program Cooperative Group. "Five-year findings of the Hypertension Detection and Follow-Up Program. I. Reduction in mortality of persons with high blood pressure, including mild hypertension. *JAMA*, Vol. 242, No. 23, December 7, 1979, pp. 2562-71
18. Management Committee of the Australian Therapeutic Trial in Mild Hypertension: "Untreated Mild Hypertension." *The Lancet*, January 23, 1982, pp. 185-91
19. Medical Research Council Working Party. "MRC trial of treatment of mild hypertension: principal results." *British Medical Journal*, Vol. 291, July 13, 1985, pp. 97-104
20. Sokolow, M.; Perloff, D.; Cowan, R.: "Contribution of Ambulatory Blood Pressure to the Assessment of Patients with Mild to Moderate Elevation of Office Blood Pressure." *Cardiovascular Review and Reports*, Vol. 1, No. 4, July 1980, pp. 295-303
21. Waeber, B.; Jacot des Combes, B; et. al.: "Ambulatory Blood Pressure Recording to Identify Hypertensive Patients Who Truly Need Therapy." *Journal of Chronic Diseases*, Vol. 37, No. 1, 1984, pp. 55-7

REFERENCES (Continued)

Page 3

22. Bloom, J.R.; Monterossa, S.: "Hypertension Labeling and Sense of Well-Being." *American Journal of Public Health*, Vol. 71, No. 11, Nov. 1981, pp. 1228-32
23. Pooling Project Research Group: Relationship of blood pressure, serum cholesterol, smoking habits, relative weight and ECG abnormalities to incidence of major coronary events: Final Report of the Pooling Project." *Journal of Chronic Diseases*, Vol. 3, 1978, p. 201
24. Shurtleff, D.: "An epidemiological investigation of cardiovascular disease. The Framingham Study." DHEW Publication No. 74-599, 1974
25. Bulpitt, C.J.: "Prognosis of Treated Hypertension 1951-1981." *Br. J. Clin. Pharmacol.*, Vol. 13, No. 1, Jan. 1982, pp. 73-9
26. Heller, R.F.; Chinn, S.; et. al.: "How well can we predict coronary heart disease? Findings in the United Kingdom Heart Disease Prevention Project." *British Medical Journal*, Vol. 288, No. 6428, May 12, 1984, pp. 1409-11
27. Savage, D.D.; Abbott, R.D.; et. al.: "Epidemiologic Features of Left Ventricular Hypertrophy in Normotensive and Hypertensive Subjects." *Cardiac Left Ventricular Hypertrophy*, eds. Ter Keurs, HEDJ and Schipperheyn, JJ publishers - Martinus-Nijhoff, The Hague 1983, pp. 2-15
28. Perloff, D.; Sokolow, M.; Cowan, R.: "The Prognostic Value of Ambulatory Blood Pressures." *JAMA*, Vol. 249, No. 20, May 27, 1983, pp. 2792-8
29. Devereux, R.B.; Pickering, T.G.; Harshfield, G.A.; et. al.: "Left ventricular hypertrophy in patients with hypertension: importance of blood pressure response to regularly recurring stress." *Circulation*, Vol. 68, 1983, pp. 470-6
30. Floras, J.S.; Jones, J.V.; et. al.: "Cuff and ambulatory blood pressure in subjects with essential hypertension." *Lancet*, Vol. 2, 1981, pp. 107-9
31. Multiple Risk Factor Intervention Trial Research Group. "Multiple risk factor intervention trial: risk factor changes and mortality results." *JAMA*, Vol. 248, 1982, pp. 1465-77
32. Doyle, A.E.: "Australian therapeutic trial in mild hypertension." *Clin. Sci.*, Vol. 63, 1982, pp. 431s-4s

REFERENCES (Continued)

Page 4

33. Helgeland, A.: "Treatment of mild hypertension: a five-year controlled drug trial: The Oslo Study." *American Journal of Medicine*, Vol. 69, 1980, pp. 725-32
34. Kannel, W.B.: "Meaning of the downward trend in cardiovascular mortality." *JAMA*, Vol. 247, 1982, pp. 877-80
35. Wing, S.; Manton, K.G.: "The Contribution of Hypertension to Mortality in the U.S. in 1968, 1977." *AJPH*, Vol. 73, No. 2, February 1983, pp. 140-4
36. Jackson, G.; Mahon, W.: "Inappropriate Antihypertensive therapy in the elderly." *The Lancet*, Dec. 18, 1976, pp. 1317-8
37. Libow, L.S.; Butler, B.N.: "Treating mild diastolic hypertension in the elderly: Uncertain benefits and possible dangers." *Geriatrics*, Vol. 36, No. 11, Nov. 1981, pp. 55-63
38. Stewart, I.: "Relation of Reduction in Pressure to First Myocardial Infarction in Patients Receiving Treatment for Severe Hypertension." *The Lancet*, April 27, 1979, pp. 861-5
39. Gould, G.A.; Mann, S.; et. al.: "Does placebo lower blood pressure?" *Lancet*, Vol. 2, 1981, pp. 1377-81
40. Kennedy, H.L.; Padgett, N.E.; et. al.: "Verification of Physician Assessment of Antihypertensive Therapy by Ambulatory Blood Pressure Recording." *The American Journal of Cardiology*, Vol. 45, Feb. 1980, pp. 490-3
41. Rion, F.; Waeber, B.: "Blood Pressure Response to Antihypertensive Therapy: Ambulatory versus Office Blood Pressure Readings." *Journal of Hypertension*, Vol. 3, No. 2, 1985, pp. 139-42
42. Berglund, G.; de Faire, U.: "Monitoring 24-Hour Blood Pressure in a Drug Trial." *Hypertension*, Vol. 7, No. 5, September-October 1985, pp. 688-94
43. Haynes, R.B.; Sackett, D.L.; Taylor, D.: "Increased Absenteeism from Work After Detection and Labeling of Hypertensive Patients." *The New England Journal of Medicine*, Vol. 292, No. 14, October 5, 1978, pp. 742-4

REFERENCES (Continued)

Page 5

44. Taylor, D.W.; Haynes, R.B.; Sackett, D.L.; Gibson, E.S.: "Longterm Follow-Up of Absenteeism Among Working Men Following the Detection and Treatment of Their Hypertension." *Clinical and Investigative Medicine*, Vol. 4, Nos. 3/4, 1981, pp. 173-7
45. Charlson, M.E.; Alderman, M.; Melcher, L. : "Absenteeism and Labeling in Hypertensive Subjects." *The American Journal of Medicine*, Vol. 73, No. 2, August, 1982, pp. 165-70
46. McCarron, D.A.; Hare, L.E.; Walker, B.R. : "Therapeutic and Economic Controversies in Antihypertensive Therapy." *Journal of Cardiovascular Pharmacology*, Vol. 6, Suppl. 5, 1984, pp. S837-40
47. United States Government, OHCT, NCHSR, OASH, DHHS, "Fully Automated Blood Pressure Monitoring of Hypertension" Vol. 3(9), 1983
48. Drayer, J.I.M.; Weber, M.A.; "Automated Ambulatory Blood Pressure Monitoring: A Study in Age-Matched Normotensive and Hypertensive Men." *American Heart Journal*, Vol. 109, No. 6, June 1985, pp. 1334-8
49. Savage, D.D.; Garrison, R.J.; Castelli, W.P.; Kannel, W.B.; Anderson, S.J.; Feinleib, M.: "Echocardiographic left ventricular hypertrophy in the general population is associated with increased 2-year mortality, independent of standard cardiovascular risk factors - The Framingham Study." *American Heart Association Council on Cardiovascular Epidemiology Newsletter*, 1985; 37:33
50. Casale, P.N.; Devereux, R.B.; et. al.: "Value of Echo cardiographic Left Ventricular Mass in Predicting Cardiovascular Morbid Events in Hypertensive Men." *Circulation*, 1985; p. 72 (suppl)
51. Rowlands, D.B.; Glover, D.R.; Ireland, M.A.; McLeary, N.A.B.; Stallard, T.J.; Watson, R.D.S.; Littler, W.A.: "Assessment of left ventricular mass and its response to antihypertensive treatment." *Lancet*, 1982; 1:467-470
52. Drayer, Jim; Weber, M.A.; de Young, J.L.: "Blood pressure a determinant of cardiac left ventricular muscle mass." *Arch. Intern. Med.*, 1983; 143:90-92

REFERENCES (Continued)

Page 6

53. Mann, et. al.: "Statistical Evaluation of Incremental Value of 24-Hour Versus Casual Blood Pressure for Predicting Concurrent Target Organ Involvement and Subsequent Clinical Morbid Events in 137 Patients." *Journal of Clinical and Experimental Hypertension*, Vol. A7, 1985, pp. 279-81
54. Pessina, A.C.; et. al.: "Relation of Casual and Automatic Ambulatory Blood Pressures to Target Organ Scores in Hypertensive Patients." *Journal of Clinical and Experimental Hypertension*, Vol A7, 1985, pp. 267-78
55. Carr, A.A.; Prisant, L.M.: "Automated 24 Hour Ambulatory Blood Pressure Monitoring: A Report." *Hypertension Section, Medical College of Georgia, Augusta, GA, 1986*
56. Ayman, D.; Goldshine, A.D.: "Blood Pressure determinations by patients with essential hypertension. I. The difference between clinic and home readings before treatment." *American Journal of Medical Science*, Vol. 200, 1940, p. 465
57. Hunt, J.C.; Frohlich, E.D.; et. al.: "Devices Used for Self-Measurement of Blood Pressure: Revised Statement of the National High Blood Pressure Education Program" *Arch. Intern. Med.*, Vol. 145, Dec. 1985, pp. 2231-2234
58. Kleinert, H.D.; Harshfield, G.A.; Pickering, T.G.; Devereux, R.B.; Sullivan, P.A.; Marion, R.M.; Mallory, W.K.; Laragh, J.H.: "What is the value of home blood pressure measurement in patients with mild hypertension?" *Hypertension*, 1984, Vol. 6, pp. 574-8
59. Health and Public Policy Committee, American College of Physicians: "Automated Ambulatory Blood Pressure Monitoring." *Ann. Intern. Med.* 104(2), Feb. 1986, pp. 275-28
60. U.S. Department of Health and Human Services, Public Health Service, National Institute of Health: "The 1984 Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure." NIH Publication No. 84-1088, June 1984
61. Reeves, R.A.; Johnsen, A.M.; Shapiro, A.P.; Traub, Y.M.; Jacob, R.G.: "Ambulatory blood pressure monitoring: Methods to assess severity of hypertension, variability and sleep changes." *AMBULATORY BLOOD PRESSURE MONITORING*, Weber, M.A. and Drayer, J.I.M. (Eds.), Springer-Verlag, New York, 1984, pp. 27-34

REFERENCES (Continued)

Page 7

62. Reeves, R.A.; Shapiro, A.P.; Thompson, M.E.; Johnsen, A.M.: "Loss of nocturnal decline in blood pressure after cardiac transplant." *Circulation*, 1986, 7:401-8
63. Reeves, R.A.; Shapiro, A.P.; McDonald, R.H.; Jacob, R.G.; Traub, Y.M.: "Methodological considerations in ambulatory blood pressure monitoring." *NEW AND SENSITIVE INDICATORS OF HEALTH IMPACTS OF ENVIRONMENTAL AGENTS*, Proceedings of the Third Annual Symposium on Environmental Epidemiology, April, 1982, Underhill, D.W. and Radford, E.P. (Eds.), University of Pittsburgh GSPH, Pittsburgh, PA, 1986, pp. 51-70
64. Jacob, R.G.; Shapiro, A.P.; Reeves, R.A.; Johnsen, A.M.; McDonald, R.H.; Coburn, P.C.: "Comparison of relaxation therapy for hypertension with placebo, diuretics or beta blockers." *Archives of Internal Medicine* (IN PRESS)

Appendix A

PUBLIC AND PRIVATE ORGANIZATIONAL VIEWS ON FAABPM

In 1983, the Office of Health Technology Assessment (OHTA), National Center for Health Services Research/Health Care Technology Assessment of the Department of Health and Human Services issued their assessment of FAABPM technology. FAABPM was recognized as a safe and an accurate method of obtaining multiple blood pressures; however, OHTA concluded that FAABPM remains an investigational technology.

In 1985, the National High Blood Pressure Education Program (NHBPEP) published a revised statement on 24-hour ambulatory blood pressure monitors.⁵⁷ NHBPEP stated:

It is important to note that continuous 24-hour monitoring systems are for use in a selected number of patients and are not intended as a routine, practical, or cost-effective means for following the majority of patients being treated for essential hypertension. Definition of the full clinical usefulness of ambulatory blood pressure monitoring requires further investigation.

The American College of Physicians recently released its recommendations regarding FAABPM.⁵⁹ The report states:

Hypertension is a major risk factor associated with two leading causes of morbidity and mortality in the United States: coronary artery disease and cerebrovascular disease. Better management of the hypertensive patient depends in part on specific and accurate diagnosis. Additional studies may show that automated ambulatory blood pressure monitoring allows physicians to identify and manage patients who would benefit from therapeutic intervention more accurately and specifically than do office blood pressure readings. At present, however, it is not known whether treatment based on readings from ambulatory blood pressure monitoring results in a lower

frequency of subsequent hypertensive complications. In addition, it is not known which of the possible measurements are most important - home or work environment readings, percentage of time above certain levels, or average blood pressure readings - and whether these differ with type of end-organ damage (for example, stroke, cardiovascular, peripheral vascular disease, or renal disease). Once these questions are answered the fundamental questions will remain of whether automated blood pressure monitoring offers sufficient advantage over office or manual home blood pressure measurements to justify its expense and inconvenience.