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Utility of Blood Pressure Monitoring Outside of the Clinic Setting

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Preface

The Agency for Healthcare Research and Quality (AHRQ), through its Evidence-Based Practice Centers (EPCs), sponsors the development of evidence reports and technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of health care in the United States. The reports and assessments provide organizations with comprehensive, science-based information on common, costly medical conditions and new health care technologies. The EPCs systematically review the relevant scientific literature on topics assigned to them by AHRQ and conduct additional analyses when appropriate prior to developing their reports and assessments.

To bring the broadest range of experts into the development of evidence reports and health technology assessments, AHRQ encourages the EPCs to form partnerships and enter into collaborations with other medical and research organizations. The EPCs work with these partner organizations to ensure that the evidence reports and technology assessments they produce will become building blocks for health care quality improvement projects throughout the Nation. The reports undergo peer review prior to their release.

AHRQ expects that the EPC evidence reports and technology assessments will inform individual health plans, providers, and purchasers as well as the health care system as a whole by providing important information to help improve health care quality.

We welcome written comments on this evidence report. They may be sent to: Director, Center for Practice and Technology Assessment, Agency for Healthcare Research and Quality, 6010 Executive Blvd., Suite 300, Rockville, MD 20852.

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Structured Abstract

Objectives. Ambulatory BP (ABP) and self-measured BP (SMBP) monitoring are two techniques that record frequent BP outside of the clinic setting. The overall objective of this report was to summarize evidence on the clinical utility of ABP and SMBP monitoring.

Search Strategy. Electronic searches were completed of MEDLINE®, Cochrane Collaboration CENTRAL Register of Controlled Trials, and HealthSTAR. Hand searching was completed of key journals, conference proceedings and references lists. Electronic searching was completed to March 2001, and hand searching was completed to May 2001.

Selection Criteria. Articles were included in this evidence synthesis if they were English-language reports of original data that addressed one of the specific research questions in nonpregnant adults.

Main Results. Eighteen studies compared clinic BP, SMBP, and/or ABP. For both systolic and diastolic BP, clinic measurements exceeded SMBP and ABP. Few studies compared SMBP and ABP. Sixteen studies determined the prevalence of white coat hypertension (WCH). Overall, WCH prevalence was approximately 20 percent among hypertensives but varied considerably by definition. Few studies assessed the reproducibility of WCH (two studies) or the reproducibility of differences between clinic BP and either ABP (one study). In cross-sectional studies of BP with left ventricular mass and/or albuminuria (25 studies), ABP levels were directly associated with both measurements; also, left ventricular mass was less in individuals with WCH than in those with sustained hypertension. Ten prospective studies assessed the relationship of ABP with subsequent clinical outcomes. In each study, at least one dimension of ABP predicted outcomes. WCH predicted a reduced risk of CVD events compared to sustained hypertension. However, data were inadequate to compare the risk associated with WCH to the risk associated with normotension. A nondipping or inverse dipping pattern predicted an increased risk of clinical outcomes. The literature was insufficient to determine whether absolute SMBP levels or WCH based on SMBP was associated with left ventricular mass or proteinuria (just one study) or whether SMBP measurements predicted subsequent CVD (just one study). In both cross-sectional and prospective studies, the poor or uncertain quality of clinic measurements precluded a satisfactory comparison of SMBP and ABP with clinic BP. Twelve trials assessed whether use of SMBP had an impact on BP control. In half of these studies, including two trials that tested contemporary devices, use of SMBP was associated with reduced BP. The availability of just two ABP trials limited inferences about the utility of ABP to guide BP management. In general, few studies reported enrollment of African-Americans. Studies infrequently reported results stratified by gender. The only notable subgroup finding was a higher prevalence of WCH in women than men.

Conclusions. In cross-sectional studies, ABP levels and ABP patterns were associated with BP-related target organ damage. Likewise, in prospective studies, higher ABP, sustained BP, and a nondipping ABP pattern were associated with an increased risk of subsequent CVD events. Few

studies examined corresponding relationships for SMBP. An inadequate number of clinic BP measurements, as well as the poor or uncertain quality of these measurements, precluded satisfactory comparisons of risk prediction based on ABP or SMBP with risk prediction based on clinic BP. In aggregate, these findings provide some evidence that ABP monitoring is useful in evaluating prognosis. However, evidence was insufficient to determine whether the risks associated with WCH are sufficiently low to consider withholding drug therapy in this large subgroup of hypertensive patients. For SMBP, available evidence suggested that use of SMBP can improve BP control; however, further trials that evaluate contemporary SMBP devices are needed.

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Overview

Elevated blood pressure (BP), also termed hypertension, is a common, powerful, and independent risk factor for cardiovascular diseases (CVD) and kidney disease. Approximately 25 percent of the adult U.S. population, about 50 million persons, has hypertension, defined as current use of anti-hypertensive medication, a systolic BP ≥140 mmHg, and/or diastolic BP ≥ 90 mmHg.

In view of the epidemic of high BP and its complications, prevention and control of high BP continues to be a major national health priority. Governments, institutions, health care providers, insurers, private industry, and non-profit organizations have committed substantial resources to prevent and treat hypertension. Still, hypertension control rates have been unsatisfactory.

Measuring BP to diagnose hypertension and to monitor therapy is problematic. Concomitantly, the enormous scope of the BP problem, the high aggregate costs of hypertension care, and the potential for medication side effects have spawned efforts to target therapy more effectively. This entails identifying lower risk individuals who might be candidates for less aggressive therapy and higher risk individuals who should receive more aggressive therapy. Measurement of BP outside of the office or clinic setting by ambulatory BP (ABP) monitoring and self-measured BP (SMBP) monitoring might accomplish these objectives.

Clinic Blood Pressure Measurements

BP as recorded in the office or clinic setting is the standard technique recommended for measurement of BP in routine medical care. The standard technique includes use of a mercury sphygmomanometer (or a calibrated aneroid device or validated electronic device) and an appropriate-sized cuff. Prior to measurement, patients should rest quietly in the seated position for several minutes. At each visit, at least two readings should be obtained. Except for those individuals with extremely high BP, the diagnosis of hypertension and adjustments in medication should then be based on the average of readings across two or more visits.

Clinic BP measurements have several limitations, even if they are measured according to established guidelines. First, clinic BP measurements exhibit enormous variability, which hinders accurate classification and which frustrates providers and patients. Another limitation is that BP measured in the clinic may not be a representative estimate of usual BP outside the clinic setting. Commonly, BP rises in the clinic setting, in response to the observer and/or other aspects of the medical environment. The difference between measurements obtained in and outside the clinic setting leads to confusion about the diagnosis of hypertension and the need to start or modify therapy. Unfortunately, there are additional limitations because clinic measurements often do not conform to established guidelines. Specific limitations include lack of observer training, inadequate rest period prior to initial measurement, use of wrong-sized cuffs, rapid deflation of cuff, incorrect position of patients, and awkward position of the observer and/or manometer.

Over the past several years, stationary automated devices and aneroid devices have increasingly replaced mercury

sphygmomanometers in the clinic setting. Aneroid devices are inexpensive but still require an individual, typically a health care provider, to manually inflate a cuff and record the appearance and disappearance of Korotkoff sounds. In contrast, fully automated devices require minimal technical skills, that is, only placement of a cuff and initiation of a reading. An additional reason leading to greater use of aneroid and automated devices stems from concerns over mercury toxicity.

Self-measured Blood Pressure (SMBP)

SMBP devices include mercury sphygmomanometers, aneroid manometers, semiautomatic devices, and fully automatic electronic devices. Automatic devices measure BP using an oscillometric technique in which systolic and diastolic BP are estimated from the pattern of vibrations in the cuff as it is deflated. Fully automated devices are popular because the patient does not have to inflate the cuff or listen for the appearance and disappearance of Korotkoff sounds. Although numerous, perhaps hundreds, of SMBP devices are on the market, very few have been independently validated.

SMBP devices provide an opportunity to record BP at home, outside of the artificial setting of the medical office or clinic. Ideally, the patient is trained to record BP using a standard technique. Occasionally, physicians may observe the patient recording a BP measurement in the clinic and then perform a cross check of readings. The presentation of SMBP data is extraordinarily variable. Commonly, patients at their own initiative provide written lists of readings to their physicians at office visits. However, recent innovations have greatly enhanced the potential utility of SMBP devices to synthesize and present data. Contemporary SMBP devices have the capacity to store and download readings via phone or computer. Data can then be synthesized and reports can be generated and sent to the patient and/or physician.

SMBP has several potential uses. Repeated measurements, if averaged, should provide a more precise estimate of usual BP than occasional measurements obtained in the clinic. As a substitute for clinic BP, SMBP monitoring could then be used to adjust anti-hypertensive drug therapy and thereby reduce the need for frequent clinic visits and their associated costs and inconvenience. The extent to which physicians, or patients, use SMBP data to adjust medication is unclear. In addition, self-measurement of BP has also been proposed as a means to improve adherence with treatment.

Self-measurement of BP theoretically provides a means to diagnose white coat hypertension (WCH), also termed non-sustained or office hypertension. This pattern refers to an elevation of clinic BP in the hypertensive range but normal or low BP outside the clinic setting. Individuals with WCH may be at comparatively low risk for BP-related complications in comparison to individuals with sustained hypertension. An important issue is whether the risk of WCH exceeds that of nonhypertensives.

Ambulatory Blood Pressure (ABP) Measurement

ABP monitoring is a noninvasive, fully automated technique in which BP is recorded over an extended period of time, typically 24 hours. The required equipment includes a cuff, a small monitor (attached to a belt), and a tube connecting the monitor to the cuff. Usually, a trained technician places the device on the patient, provides instructions to the patient, and then downloads data from the device when the patient returns. Most ABP devices use an oscillometric technique. Compared to SMBP, relatively few ABP devices are on the market. However, in contrast to SMBP devices, most currently available ABP devices have undergone validation testing, as recommended by the American Association of Medical Instrumentation (AAMI) or the British Hypertension Society (BHS).

During a typical ABP monitoring session, BP is measured every 15 to 30 minutes over a 24-hour period (including both awake and asleep hours). The total number of readings usually varies between 50 and 100. BP data are stored in the monitor and then downloaded into device-specific computer software. The raw data can then be synthesized into a report that provides mean values by hour and period (daytime [awake], nighttime [asleep], and 24-hour BP), both for systolic and diastolic BP. The most common output used in decisionmaking are absolute levels of BP, that is, mean daytime, nighttime, and 24-hour values. Because of the expense of ABP equipment (up to $5,000 for a monitor, cuff set, and software), the requirement for technicians, the inconvenience and logistics of placing and removing ABP devices, and, until recently, the lack of reimbursement, it is uncommon for ABP monitoring to be done frequently. However, use of ABP will likely increase as a result of the decision by the Centers for Medicare and Medicaid Services (CMS) to cover ABP in selected settings, namely, the identification of WCH.

In addition to mean absolute levels of ABP, certain ABP patterns may predict BP-related complications. The patterns of greatest interest are WCH and nondipping BP. Using both daytime and nocturnal ABP, one can identify individuals, termed nondippers, who do not experience the decline in BP that occurs during sleep hours. Usually, nighttime (asleep) BP drops by 10 percent or more from daytime (awake) BP. Research has suggested that individuals with a nondipping pattern (less than 10-percent BP reduction from night to day) may be at increased risk of BP-related complications compared to those with a normal dipping pattern.

Although ABP could be used to monitor therapy, the most common application is diagnostic, that is, to ascertain an individualís usual level of BP outside the clinic setting and thereby identify individuals with WCH. In addition to detection of WCH, ABP devices may be used to identify individuals with a nondipping BP pattern and to evaluate apparent drug resistance, hypotensive symptoms to medications, episodic hypertension, and autonomic dysfunction. Use of ABP monitoring has been controversial. First, few prospective studies have determined whether this technology predicts cardiovascular disease outcomes and whether this technology provides additional information beyond that of routine clinic measurements. Second, insurers have been concerned that health care providers might overutilize ABP. Third, it has been unclear whether SMBP monitoring is a satisfactory and less expensive alternative to ABP monitoring. Accordingly, health insurers have been reluctant to reimburse for ABP monitoring.

Reporting the Evidence

The utility of BP monitoring outside of the clinic setting was a topic nominated to the Agency for Healthcare Research and Quality (AHRQ) by a group of experts in BP measurement. In September of 2000, the AHRQ awarded a contract to the Johns Hopkins Evidence-based Practice Center (EPC) to prepare an evidence report on this topic. The Johns Hopkins EPC established a team and work plan to develop a report that would identify and synthesize the best available evidence on BP monitoring. One of the first tasks was the identification of an appropriate partner. In December 2000, the National High Blood Pressure Education Program (NHBPEP) of the National Heart, Lung, and Blood Institute (NHLBI) of the National Institutes of Health (NIH) hosted a working meeting. The NHBPEP includes representatives from national professional and voluntary organizations as well as from Federal agencies. Arising from that meeting was an agreement from the NHBPEP Coordinating Committee to partner with the Johns Hopkins EPC on this project.

A core group of five clinically and/or methodologically oriented technical experts advised the EPC team at key points in the project. This group included experts in ABP monitoring, SMBP monitoring, clinic BP measurement, clinical hypertension, and diagnostic test evaluation. These individuals reviewed draft research questions. Also, this core group along with additional experts in BP measurement and hypertension provided early input at an ad hoc meeting convened by the NHBPEP. The target population consisted of nonpregnant adults with BP in the nonhypertensive or hypertensive range. These individuals are candidates for BP monitoring, and many are candidates for anti-hypertensive drug therapy.

Key Questions

After an extensive deliberative process and with input from the technical experts, the following questions were developed:

- Comparison of clinic, ambulatory, and SMBP readings.
  - 1a. What is the distribution of the BP differences between clinic, ambulatory, and SMBP readings? If there are differences, are these differences reproducible?
  - 1b. What is the prevalence of WCH as defined by SMBP? Is this pattern reproducible?
  - 1c. What is the prevalence of WCH as defined by ABP measurement? Is this pattern reproducible?
- SMBP levels and WCH based on SMBP as related to clinical outcomes.
  - 2a. Is SMBP more or less strongly associated with BP-related target organ damage than clinic BP measurements?
  - 2b. Does SMBP predict subsequent clinical outcomes?
  - 2c. What is the incremental gain in prediction of clinical outcomes from use of self-measurement devices beyond prediction from clinic BP alone?
  - 2d. What is the effect of treatment guided by SMBP in comparison to treatment guided by clinic BP, in terms of:
    - i. BP-related target organ damage
    - ii. symptoms
    - iii. use of anti-hypertensive drug therapy
    - iv. BP control
- ABP levels and WCH based on ABP as related to clinical outcomes
  - 3a. Is ambulatory blood pressure more or less strongly associated with BP-related target organ damage than clinic BP measurements?
  - 3b. Does ambulatory blood pressure predict subsequent clinical outcomes?
  - 3c. What is the incremental gain in prediction of clinical outcomes from use of ambulatory devices beyond prediction from clinic BP alone?
  - 3d. What is the effect of treatment guided by ABP in comparison to treatment guided by clinic BP, in terms of:
    - i. BP-related target organ damage
    - ii. symptoms
    - iii. use of anti-hypertensive drug therapy
    - iv. BP control

- Does the evidence for the above questions vary according to a patient's age, gender, income level, race/ethnicity, and clinical subgroups (e.g., hypertensive/normotensive, diabetic, renal transplant status)?

Methodology

Searching the literature included identifying reference sources, formulating a search strategy for each source, and executing and documenting each search. A comprehensive search plan was developed that include electronic and hand searching. Several electronic databases were searched and a separate strategy was developed for each. First searched was MEDLINE®, which was accessed through PubMed®. Searches using PubMed® were completed in January 2001 and March 2001. The Cochrane CENTRAL Register of Controlled Trials was searched once (Issue 1, 2001). HealthSTAR was searched in February 2001.

Hand searching for possibly relevant citations took several forms. First, priority journals were identified through an analysis of the frequency of citations per journal in the database of search results as well as through discussions amongst the EPC team. Fifteen specialty and general journals were identified. The January to May 2001 issues of these journals were searched. For the second form of hand searching, a database of reference material, identified through an electronic search for relevant guidelines and reviews, through discussions with experts, and through the article review process, was created in the reference management software, ProCite. A listing of titles and abstracts from this database, the BP References Database, was reviewed by the principal investigator to identify key articles. The reference lists of these articles were then reviewed to identify possibly relevant citations. Finally, proceedings from recent conferences were also reviewed.

Abstract and Article Review Process

Specific inclusion and exclusion criteria were applied at each of three levels of review (two levels of abstract review, then article review). Inclusion criteria became more stringent at each level. The titles and abstracts were reviewed for each article identified. During the abstract review process, emphasis was placed on identifying all articles that may possibly have original data pertinent to the questions. For the first-level abstract review, titles and abstracts for all articles retrieved by the literature search were printed on an abstract form and distributed to two reviewers. Because of the extensive volume of literature, a second level abstract review, at which additional exclusion criteria were applied, was necessary. Citations deemed eligible for full article review based on the initial abstract review were printed onto the second level abstract form and distributed to two reviewers.

The purpose of the article review was to confirm the relevance of each article to the research questions, to determine methodological characteristics pertaining to study quality, and to collect evidence that addressed the research questions. Because of the large number of citations that remained eligible for full article review even after the second level abstract review, additional exclusion criteria were applied at the article review level. The final full list of exclusion criteria differed by question. For instance, for question 1a, a comparison of BP by the different techniques, the criterion of more than 1 day of measurement for clinic BP was added because an average clinic BP based on just 1 day of measurements (typically just one to three readings) is extremely imprecise and could lead to a biased comparison with ABP or SMBP.

Article review forms were developed to collect data in a standardized fashion. This process was complex and time consuming due to the heterogeneity of the literature and the diverse questions being addressed. These forms then guided article review. For each of the articles deemed potentially eligible after second-level abstract review, two reviewers read the article, confirmed eligibility status, abstracted key information, and assessed study quality on several dimensions. Because of heterogeneity in study design, data collection forms and elements differed by research question.

Presentation of Results

Evidence tables that summarize aspects of study quality, characteristics of the study population, and features of BP measurement were constructed. For most research questions, these summary tables were similar. However, the evidence tables that display study results differed substantially by research question. Qualitative summaries were prepared which synthesized the evidence and included, to a limited extent, a quantitative assessment (for example, the number/percent of studies with significant associations, overall and occasionally by relevant study characteristics). A draft version of the report was distributed to the partner, the technical advisory group, and other peer reviewers. All substantive comments were collated, the responses of the EPC team summarized, and edits were made to the report as appropriate.

Findings

Key question 1. Comparison of clinic BP, SMBP, and ABP readings.

- *Question 1a. Distribution of BP differences.*

  A total of 18 studies addressed the distribution of BP differences. BP levels measured outside the clinic setting differed from those obtained in the clinic. For both systolic and diastolic BP, clinic measurements exceeded SMBP, daytime ABP,

nighttime ABP, and 24-hour ABP. In the few studies that compared SMBP and ABP, daytime ABP and SMBP appeared similar, while nighttime ABP was consistently lower than SMBP. The literature was insufficient to determine whether these BP differences are reproducible.

- *Question 1b. Prevalence of WCH based on SMBP.*

  A total of four studies addressed this issue. Hence, the literature was insufficient to determine the prevalence of WCH by SMBP.

- *Question 1c. Prevalence of WCH based on ABP*.

  A total of 16 studies addressed this issue. Prevalence varied by WCH definition and study population. Overall, the prevalence was approximately 20 percent among patients with hypertension. Only two studies addressed the reproducibility of WCH. Hence, the literature was insufficient to determine whether WCH based on ABP is reproducible.

Key question 2. The relationship of SMBP levels and WCH based on SMBP to clinical outcomes.

- *Question 2a. Associations of SMBP with target organ damage.*

  Only one study addressed this issue. Hence, the literature was insufficient to determine the associations of absolute SMBP levels or WCH as determined by SMBP with left ventricular mass or proteinuria.

- *Question 2b. Associations of SMBP with clinical outcomes in prospective studies.*

  Only one study addressed this issue. Hence, the literature was insufficient to determine whether absolute SMBP levels or WCH based on SMBP predicts subsequent CVD.

- *Question 2c. Comparison of risk prediction from SMBP and clinic BP.*

  Only one study addressed this issue. The dearth of studies combined with the poor or uncertain quality of clinic BP measurements precluded an answer to this question.

- *Question 2d. Effect of treatment guided by SMBP.*

  Twelve trials addressed this issue, but the evidence was inconsistent. In half of these trials, interventions that included SMBP led to reduced BP. Two trials used contemporary SMBP technology which can store and synthesize SMBP measurements and which can generate BP reports. In both of these trials, the SMBP intervention led to reduced BP.

Key question 3. The relationship of ABP levels and WCH based on ABP to clinical outcomes.

- *Question 3a. Cross-sectional associations of ABP with target organ damage.*

  A total of 25 studies addressed these issues. Left ventricular mass and albuminuria were positively associated with ABP.

- *Question 3b. Associations of ABP with clinical events in prospective studies.*

  A total of 10 studies addressed this issue. In each study, at least one dimension of ABP predicted subsequent clinical events, primarily CVD. In two of these studies, WCH was associated with a reduced risk of CVD relative to the risk associated with sustained hypertension. No prospective study adequately compared the risk associated with WCH relative to the risk associated with non-hypertension. In four of five studies, a nondipping or inverse dipping pattern predicted an increased risk of adverse events.

- *Question 3c. Comparison of risk prediction from ABP and clinic BP.*

  A total of nine prospective studies addressed this issue, but only two studies assessed incremental gain, that is, whether ABP provided additional information that was predictive of risk beyond that of clinic BP. However, the poor or uncertain quality of clinic BP measurements precluded a satisfactory comparison of risk prediction from ABP and clinic BP.

- *Question 3d. Effect of treatment guided by ABP.*

  Only two trials addressed this issue. Hence, the literature was insufficient to determine the effects of treatment guided by ABP.

Key question 4. Findings according to subgroups.

- The vast majority of studies included both men and women, but few studies reported results separately by gender.
- Few studies reported enrollment of African-Americans, and race-stratified data were rarely presented.
- The only notable subgroup finding was a higher prevalence of WCH in women than in men.

In summary, ABP levels and ABP patterns were associated with BP-related target organ damage in cross-sectional studies. Likewise, in prospective studies, higher ABP, sustained hypertension, and a nondipping ABP pattern were associated with an increased risk of subsequent CVD events. Few studies examined corresponding relationships for SMBP. An

inadequate number of clinic BP measurements, as well as the poor or uncertain quality of clinic BP measurements, precluded satisfactory comparisons of risk prediction based on ABP or SMBP with risk prediction based on clinic BP. In aggregate, these findings provide some support for use of ABP monitoring in evaluating prognosis. However, evidence was insufficient to determine whether the risks associated with WCH are sufficiently low to consider withholding drug therapy in this large subgroup of hypertensive patients. For SMBP, available evidence from several trials suggested that use of SMBP can improve BP control; however, further trials that evaluate contemporary SMBP devices are needed.

Future Research

The optimal approach to measure BP remains uncertain. In view of the high prevalence of uncontrolled hypertension, the continuing epidemic of BP-related diseases, and the potential for alternative measurement techniques to improve diagnosis and target therapy, there is a need for comparative studies that assess the relative efficacy, feasibility, and costs of ABP, contemporary SMBP technology, and clinic BP. Specific types of research needs are as follows:

- Prospective observational studies that include SMBP, ABP, and clinic BP. Specific research questions include:
  - What is the repeatability of WCH?
  - What are the risks associated with WCH? In particular, is the risk associated with WCH sufficiently low to justify non-treatment? If yes, in which patients?
  - Does WCH as assessed by SMBP carry the same risk as WCH as assessed by ABP?
  - What are the risks associated with nondipping status?
  - Is nondipping status a surrogate for some other variable that might be measured more easily, that is, without ABP?
  - What is the incremental gain from use of SMBP or ABP over clinic BP alone?
- Clinical trials that test whether contemporary SMBP technology, compared to conventional management by clinic BP, can improve BP control and health outcomes. An additional comparison group might include BP management by ABP. These trials should also compare the aggregate costs of these approaches.
- Decision analyses that determine the costs and effects of strategies that integrate clinic BP, SMBP, and ABP.
- Synthesis of evidence on BP measurements in clinic setting, including issues related to the accuracy and performance of different devices (mercury, aneroid, automated BP) and different observers (physicians, nurses, technicians).

In future research, clinic BP should be measured appropriately by trained observers using validated equipment; measurements should be obtained at several visits. Also, because of the dearth of large-scale, high-quality studies, there is a clear need for government sponsorship of key studies.

To improve the quality of ABP and SMBP publications, standardized methods should be disseminated to researchers and authors. Also, journals should require standardized approaches for presenting ABP data. For published articles, full copies of protocols should be made available, perhaps on the Web. This is especially important because the intense pressure from editors to shorten manuscripts typically leads to reductions in the methods section.

Availability of the Full Report

The full evidence report from which this summary was taken was prepared for the Agency for Healthcare Research and Quality (AHRQ) by the Johns Hopkins Evidence-based Practice Center (EPC), Baltimore, MD, under contract number 290-97-006. It is expected to be available in fall 2002. At that time, printed copies may be obtained free of charge from the AHRQ Publications Clearinghouse by calling 800-358-9295. Requesters should ask for Evidence Report/Technology Assessment No. 63, *Utility of Blood Pressure Monitoring Outside of the Clinic Setting*. In addition, Internet users will be able to access the report and this summary online

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Evidence Report

Chapter 1: Introduction

Background

Elevated blood pressure (BP), also termed hypertension, is a common, powerful, and independent risk factor for cardiovascular diseases (CVD) and kidney disease. BP-related CVD include cerebrovascular disease (or stroke), coronary heart disease (CHD), heart failure, and peripheral artery disease. The risk relationships are progressive and graded such that the risk of these diseases rises throughout the range of BP including BP in the non-hypertensive range.[1,2]

Approximately 25 percent of the adult U.S. population, about 50 million persons, has hypertension, defined as current use of anti-hypertensive medication, a systolic BP $\geq$140 mmHg, and/or diastolic BP $\geq$ 90 mmHg.[3] Less than half of adults have optimal BP defined as systolic BP < 120 mmHg and DBP < 80 mmHg. Hypertension disproportionately affects certain subgroups, particularly African-Americans and older-aged persons. With increasing age, the prevalence of hypertension rises such that over 50 percent of U.S. adults ages 60 years and older have hypertension. While hypertension affects both genders, men have a higher prevalence than women at younger ages, but the opposite is true at later ages (> approximately 50 years).

A compelling body of evidence from clinical trials has documented that drug therapy not only lowers BP but also prevents stroke, CHD and heart failure.[4,5] A complementary strategy to drug therapy for hypertension is non-pharmacologic, lifestyle therapy. A substantial body of research has documented that lifestyle modification can lower BP and prevent hypertension in non-hypertensive individuals who are not candidates for drug therapy but who nonetheless remain at risk for BP-related complications.[6]

In view of the epidemic of high BP and its complications, prevention and control of high BP continues to be a major national health priority. Governments, institutions, health care providers, insurers, private industry and non-profit organizations have committed substantial resources to research aimed at prevention and treatment of hypertension. Professional organizations and governmental bodies have developed guidelines to screen, diagnose, prevent and treat hypertension.[7] Health insurance companies typically cover the costs of anti-hypertensive care, including, to a variable extent, medication costs. Still, hypertension control rates have been unsatisfactory. In response, performance guidelines have been developed as a means to monitor and improve hypertension control.[8]

Despite this ongoing and massive effort to prevent BP-related complications, the most appropriate technique to measure BP remains uncertain, both to diagnose hypertension and to monitor therapy. Concomitantly, the enormous scope of the BP problem, the high aggregate costs of hypertension care, and the potential for medication side effects have spawned efforts to target therapy more effectively. Specifically, attention has focused on identification of lower risk individuals who might be candidates for less aggressive therapy and higher risk individuals who should receive more aggressive therapy. Measurement of BP outside of the office or clinic setting has been proposed as an alternative to traditional BP measurements. Ambulatory BP (ABP) monitoring and self-measured BP (SMBP) monitoring are two measurement techniques that can record BP outside of the clinic setting and that might accomplish the above objectives.

Clinic Blood Pressure Measurements

BP as recorded in the office or clinic setting is the standard technique recommended for measurement of BP in routine medical care.[7] Such measurements have been used in the major observational studies that documented risk relationships between BP and clinical events and in most clinical outcome trials that documented the benefits of anti-hypertensive therapy. Ideally, the observer is trained and then retrained periodically. The standard technique includes use of a mercury sphygmomanometer (or a calibrated aneroid device or validated electronic device) and an appropriate size cuff. Prior to measurement, patients should rest quietly in the seated position for several minutes. At each visit, at least two readings should be obtained. Typically, BP measurements at a given visit are then averaged. Except for those individuals with extremely high BP, the diagnosis of hypertension and adjustments in medication should then be based on the average of readings across two or more visits. Numerous national and international professional organizations have prepared guidelines for measurement of clinic BP.[7]

Clinic BP measurements have several limitations, even if they are measured according to established guidelines.[9] First, clinic BP measurements exhibit enormous variability, which hinders accurate classification and which frustrates providers and patients. Contributing to this variability are short-term variability (within clinic visit), diurnal variability (within the same day), and long-term variability (across an extended period of time, days or weeks). One solution is to measure BP across several visits, spaced several days or weeks apart. Another limitation is that BP measured in the clinic may not be a representative estimate of usual BP outside the clinic setting.[10] Commonly, BP rises in the clinic setting, in response to the observer and/or other aspects of the medical environment. An alerting reaction appears to trigger this response. The difference between measurements obtained in and outside the clinic setting leads to confusion over the diagnosis of hypertension and the need to start or modify therapy. The problem is exacerbated by the practical requirement for cutpoints to diagnose and treat hypertension despite the fact that BP is a continuous, unimodal distribution. In the end, because of misclassification, there is potential both for undertreatment of persons with high blood pressure and overtreatment of those with low blood pressure. Unfortunately, there are additional limitations because clinic measurements often do not conform to established guidelines.[11] Specific limitations include lack of observer training, inadequate rest period prior to initial measurement, use of inappropriate sized cuffs, rapid deflation of cuff, incorrect position of patients, insufficient number of BP measurements and visits, and awkward position of the observer and/or manometer.

Over the past several years, stationary automated devices and aneroid devices have increasingly replaced mercury sphygmomanometers in the clinic setting. Aneroid devices are inexpensive but still require an individual, typically a health care provider, to manually inflate a cuff and record the appearance and disappearance of Korotkoff sounds. In contrast, fully automated devices require minimal technical skills, that is, only placement of a cuff and initiation of a reading. The convenience of automated readings and the potential to avoid training and retraining of technicians has made automated readings extremely popular. An additional reason leading to greater use of aneroid and automated devices stems from concerns over mercury toxicity.[12] Specifically, to reduce the amount of mercury released into the environment and to

minimize the risk of accidental mercury exposure, government officials have encouraged health care officials to eliminate mercury from health care settings.

Self-measured Blood Pressure (SMBP)

SMBP devices include mercury sphygmomanometers, aneroid manometers, semi-automatic devices, and fully-automatic electronic devices. Automatic devices measure BP using an oscillometric technique in which systolic and diastolic BP are estimated from the pattern of vibrations in the cuff as it is deflated. This technique is quite different from the usual auscultatory technique in which systolic BP is estimated as the point of appearance of Korotkoff sounds and diastolic BP as the point of disappearance. Fully automated devices are popular because the patient does not have to inflate the cuff, listen for the appearance and disappearance of Korotkoff sounds, and read measurements off a column or dial. Hence, these devices appeal to individuals with hearing or visual impairments, or limited dexterity. Although numerous, perhaps, hundreds of SMBP devices are on the market, very few have been independently validated. In a recent review of published validation studies, only 23 devices had undergone validation testing; of these, only five were recommended by the European Society of Hypertension.[13]

SMBP devices provide an opportunity to record BP during awake hours, outside of the artificial setting of the medical office or clinic. Ideally, the patient is trained to record BP using a standard technique. Occasionally, physicians may observe the patient recording a BP measurement in the clinic and then perform a cross check of readings. While the medical literature has documented that patients can record BP accurately, there have been concerns about the accuracy of readings, the completeness of reports submitted to physicians, and the potential for biased readings based on selective reporting.[14]

The presentation of SMBP data is extraordinarily variable. Commonly, patients at their own initiative provide written lists of readings to their physicians at office visits. However, recent innovations have greatly enhanced the potential utility of SMBP devices to synthesize and present data. Contemporary SMBP devices have the capacity to store and download readings via phone or computer. Data can then be synthesized from which reports are generated and then transmitted to the patient and/or physician.

SMBP has several potential uses.[14] Repeated measurements, if averaged, should provide a more precise estimate of usual BP than occasional measurements obtained in the clinic. As a substitute for clinic BP, SMBP monitoring could then be used to adjust anti-hypertensive drug therapy and thereby reduce the need for frequent clinic visits and their associated costs and inconvenience. The extent to which physicians, or patients, use SMBP data to adjust medication is unclear. Self-measurement of BP has also been proposed as a means to improve adherence with treatment. In addition, self-measurement of BP theoretically provides a means to diagnose 'white coat hypertension (WCH)', also termed 'non-sustained' or 'office' hypertension. This pattern refers to an elevation of clinic BP in the hypertensive range but normal or low BP outside the clinic setting. Individuals with WCH may be at comparatively low risk for BP related complications in comparison to individuals with sustained BP. An important issue is whether the risk of WCH exceeds that of non-hypertensives.[10]

Ambulatory Blood Pressure (ABP) Measurement

ABP monitoring is a non-invasive, fully automated technique in which BP is recorded over an extended period of time, typically 24 hours. The required equipment includes a cuff, a small monitor (attached to a belt), and a tube connecting the monitor to the cuff. Usually, a trained technician places the device on the patient, provides instructions to the patient, and then downloads data from the device when the patient returns. Most, but not all, ABP devices use an oscillometric technique. Compared to SMBP, relatively few ABP devices are on the market. However, in contrast to SMBP devices, most currently available ABP devices have undergone validation testing, as recommended by the American Association of Medical Instrumentation (AAMI) or the British Hypertension Society (BHS). In a review of validation studies by O'Brien et al, 24 devices had undergone validation testing and 16 were recommended.[13]

During a typical ABP monitoring session, BP is measured every 15-30 minutes over a 24 hour period including both awake hours and asleep hours. The total number of readings usually varies between 50 and 100. BP data are stored in the monitor and then downloaded into device-specific computer software. The raw data can then be synthesized into a report that provides mean values by hour and period [daytime (awake), nighttime (asleep), and 24 hour BP], both for systolic and diastolic BP. The most common output used in decision making are absolute levels of BP, that is, mean daytime, nighttime, and 24 hour values. Because of the expense of ABP equipment (up to $5,000 for a monitor, cuff set and software), the requirement for technicians, the inconvenience and logistics of placing and removing ABP devices, and until recently, the lack of reimbursement, it is uncommon for ABP monitoring to be done frequently.

In addition to mean absolute levels of ABP, certain ABP patterns may predict BP-related complications. The patterns of greatest interest are 'white coat hypertension' and 'non-dipping' BP. Using both daytime and nocturnal ABP, one can identify individuals, termed 'non-dippers', who do not experience the decline in BP that occurs during sleep hours. Usually, nighttime (asleep) BP drops by 10 percent or more from daytime (awake) BP. Research has suggested that individuals with a 'non-dipping' pattern (less than 10 percent BP reduction from night to day) may be at increased risk of BP-related complications compared to those with a normal dipping pattern.[15]

Although ABP could be used to monitor therapy, the most common application is diagnostic, that is, to ascertain an individual's usual level of BP outside the clinic setting and thereby identify individuals with WCH. In addition to detection of WCH, ABP devices may be used to identify individuals with a 'non-dipping' BP pattern and to evaluate apparent drug resistance, hypotensive symptoms to medications, episodic hypertension, and autonomic dysfunction.[7] Use of ABP monitoring has been controversial. First, few prospective studies have determined whether this technology predicts cardiovascular disease outcomes and whether this technology provides additional information beyond that provided by routine clinic measurements.[16] Second, insurers have been concerned that health care providers might overutilize ABP. Third, it has been unclear whether SMBP monitoring is a satisfactory and less expensive alternative to ABP monitoring. Accordingly, health insurers have been reluctant to reimburse for ABP monitoring. Recently, however, the Centers for Medicare and Medicaid Services has decided to cover use of ABP to diagnose WCH.

Scope and Purpose of Report

This evidence report summarizes and examines the evidence supporting the clinical utility of non-invasive ABP and SMBP monitoring. Although these technologies have been proposed for use in several settings, the focus of this report was the evaluation and management of adults with elevated BP. Patient populations included in this report were non-pregnant adults with BP in the non-hypertensive or hypertensive range.

Chapter 2: Methodology

The utility of blood pressure monitoring outside of the clinic setting was a topic nominated to the Agency for Healthcare Research and Quality (AHRQ) by a group of experts in blood pressure measurement. In September of 2000, the AHRQ awarded a contract to the Johns Hopkins Evidence-based Practice Center (EPC) to prepare an evidence report on this topic. The Johns Hopkins EPC established a team and work plan to develop a report that would identify and synthesize the best available evidence on blood pressure monitoring. One of the first tasks was the identification of an appropriate partner.

In December 2000, the National High Blood Pressure Education Program (NHBPEP) of the National Heart, Lung and Blood Institute (NHLBI) of the National Institutes of Health (NIH) hosted a working meeting. The NHBPEP includes representatives from national professional and voluntary organizations as well as from federal agencies. Arising from that meeting was an agreement from the NHBPEP Coordinating Committee to partner with the Johns Hopkins EPC on this project.

The project consisted of recruiting technical experts, formulating and refining the specific questions, performing a comprehensive literature search, summarizing the state of the literature, constructing evidence tables, and submitting the report for extensive peer review.

Recruitment of Technical Experts and Peer Reviewers

Experts were sought who could provide content and/or methodological guidance. The five technical experts were chosen to cover several domains: hypertension management, SMBP, ABP, clinic BP, and evaluation of screening and diagnostic tests. Input was sought from the partner and technical experts through ad hoc correspondence as well as through more formal requests for feedback during the project. Specific requests for feedback were made for key decisions, such as selection and refinement of the questions.

Comprehensive feedback on the draft report was sought from the partner, the technical experts, and other reviewers. Reviewers included members of the NHBPEP Coordinating Committee selected through discussions with the partner. (See appendix A for list of organizations represented by reviewers from which comments were received.)

Patient Population

The search was not limited by age, gender or any other patient characteristic. However, because of the extensive volume of literature, the review did not synthesize evidence for all types of populations. For instance, it was felt that the use of blood pressure monitoring during pregnancy was a distinctive application of these technologies that was beyond the scope of this report. Likewise, articles that focused exclusively on populations of children (less than 20 years of age) were not reviewed.

Questions

The original questions provided by AHRQ included several descriptive questions that were more appropriately addressed as background text in Chapter 1. The EPC team refined the remaining questions and requested feedback from the technical experts and from the partner. When the large volume and heterogeneity of the literature became apparent, the EPC team refined the questions further. Listed below are the questions addressed in this report.

- ❑ Comparison of clinic, ambulatory, and SMBP readings:
  - 1a. What is the distribution of the BP differences between clinic, ambulatory and SMBP readings? If there are differences, are these differences reproducible?
  - 2a. What is the prevalence of WCH as defined by SMBP? Is this pattern reproducible?
  - 3a. What is the prevalence of WCH as defined by ABP measurement? Is this pattern reproducible?

- ❑ SMBP levels and WCH based on SMBP as related to clinical outcomes:
  - 2a. Is SMBP more or less strongly associated with BP-related target organ damage than clinic BP measurements?
  - 2b. Does SMBP predict subsequent clinical outcomes?
  - 2c. What is the incremental gain in prediction of clinical outcomes from use of self-measurement devices beyond prediction from clinic BP alone?
  - 2d. What is the effect of treatment guided by SMBP in comparison to treatment guided by clinic BP, in terms of:
    - i. BP-related target organ damage
    - ii. symptoms
    - iii. use of anti-hypertensive drug therapy
    - iv. BP control

- ❑ ABP levels and WCH based on ABP as related to clinical outcomes:
  - 3a. Is ambulatory blood pressure more or less strongly associated with BP-related target organ damage than clinic BP measurements?
  - 3b. Does ambulatory blood pressure predict subsequent clinical outcomes?
  - 3c. What is the incremental gain in prediction of clinical outcomes from use of ambulatory devices beyond prediction from clinic BP alone?
  - 3d. What is the effect of treatment guided by ABP in comparison to treatment guided by clinic BP, in terms of:
    - i. BP-related target organ damage
    - ii. symptoms
    - iii. use of anti-hypertensive drug therapy
    - iv. BP control

- ❑ Does the evidence for the above questions vary according to a patient's age, gender, income level, race/ethnicity, and clinical subgroups (e.g., hypertensive/normotensive, diabetic, renal transplant status)?

Causal Pathway

During its deliberations, the EPC team developed a conceptual framework to assist in the formulation of its research questions. (See Figure 1.) It is evident that several factors might influence the use and interpretation of BP measurements, including patient factors (age, race, gender, clinical conditions), technical factors (accuracy, reproducibility, operator, machine), other CVD risk factors, and response to treatment. Also, there are many potential outcomes of interest including clinical events (CHD, stroke, kidney disease), BP control, cost, side effects, and medication. The EPC team had sufficient resources to address several key points in this pathway (e.g., prognosis) but not all steps (e.g., assessment of device accuracy) or outcomes (e.g., cost). This pathway can also be used as a conceptual framework to identify gaps in the evidence.

Literature Search Methods

Searching the literature included the steps of identifying reference sources, formulating a search strategy for each source, and executing and documenting each search.

Sources

A comprehensive search plan was developed that include electronic and hand searching. Several electronic databases were searched.

First searched was MEDLINE®, or MEDlars onLINE, the database of bibliographic citations and author abstracts from over 4,000 current biomedical journals published in the United States and 70 foreign countries. MEDLINE® coverage begins in the mid 1960's. MEDLINE® was accessed through PubMed®, the Internet access to MEDLINE® provided by the National Library of Medicine (NLM). Searches using PubMed were completed in January 2001 and then again, in March 2001 for newly added citations.

The Cochrane CENTRAL Register of Controlled Trials was then searched. This is a database of all clinical trials (primarily randomized controlled trials and controlled clinical trials) identified through the searching efforts of the Cochrane Collaboration. The CENTRAL database includes search results from many electronic databases, including MEDLINE® and EMBASE, as well as results from the hand searching of more than 1,000 journals, for all publication years starting in 1948.[17] The CENTRAL database also includes the specialized register of controlled trials developed by the Cochrane Hypertension Collaborative Review Group (CRG). The Hypertension CRG has completed extensive searching of electronic databases and members of this CRG are hand searching a number of key hypertension journals such as *American Journal of Hypertension,* and the *Journal of Clinical Hypertension*. The CENTRAL database is made

available on *The Cochrane Library*, which is issued quarterly. Issue 1 of the 2001 of *The Cochrane Library* was searched.

Internet Grateful Med®, provided as a Web-based service by the NLM, was used to access HealthSTAR. This electronic database combines the former HEALTH (Health Planning and Administration) and HSTAR (Health Service/Technology Assessment Research) databases and includes over 3.1 million citations from 1975 to present. Citations include relevant bibliographic records from MEDLINE® (1975 to present) and unique records from three sources: (1) records emphasizing health care administration selected and indexed by the American Hospital Association; (2) records emphasizing health planning from the National Health Planning Information Center; and (3) records emphasizing health services research, clinical practice guidelines, and health care technology assessment selected and indexed through NLM's National Information Center on Health Services Research and Health Care Technology. HealthSTAR was searched once in February, 2001.

Hand searching for possibly relevant citations took several forms. First, priority journals were identified through an analysis of the frequency of citations per journal in the database of search results as well as through discussions amongst the EPC team. Fifteen specialty and general journals were thus identified. (See Appendix B.) The table of contents of these journals were scanned for possibly relevant citations from January 2001 to May 31, 2001. The exception to this was the *Journal of Clinical Hypertension* which, in its current form, began publishing in 1999 and was not indexed in MEDLINE® during the completion of searching for this project. The hand search of this journal started with the beginning of its publication in 1999.

For the second form of hand searching, a database of reference material, identified through an electronic search for relevant guidelines and reviews, through discussions with experts, and through the article review process, was created in the reference management software, ProCite. A listing of titles and abstracts from this database, the BP References Database, was reviewed by the principal investigator to identify key articles. The reference lists from these key articles were then examined to identify any additional articles for consideration.

Additionally, the proceedings of the following conferences were hand searched: Leuven Consensus Conference on Blood Pressure Monitoring, 1999; Annual Scientific Session of the American Heart Association Council for High Blood Pressure Research, October 2000; Annual Scientific Session of the American Heart Association, November 2000; Annual Scientific Session of American Heart Association Council on Epidemiology and Prevention, March 2001; Annual Scientific Meeting of the American Society of Hypertension, May 2001.

Search Terms and Strategies

Search strategies, specific to each database, were designed to maximize sensitivity. Initially, a core strategy for PubMed was developed based on an analysis of the Medical Subject Headings (MeSH) and text words of 47 key articles identified a priori. This strategy was then modified for use on the Cochrane CENTRAL Register of Controlled Trials and in searching HealthSTAR. (See Appendix C.)

Organization and Tracking of Literature Search

The results of the searches of electronic databases were downloaded and, using the duplication check in the bibliographic software ProCite, articles not previously retrieved were included in the Blood Pressure Citations Database. This ProCite database was used to store citations and to track the search results and sources. The results of the abstract review process were also tracked using ProCite.

Abstract Review

Specific inclusion and exclusion criteria were applied at each of three levels of review, with criteria becoming more stringent as the process moved from searching, to the review of abstracts and to the review of articles. After identifying a citation, its title and abstract were reviewed, and articles were included or excluded from the article review on this basis.

Identification of Inclusion and Exclusion Criteria

During the abstract review process, emphasis was placed on identifying all articles that may possibly have original data pertinent to the questions. As previously described, the technical experts were consulted during the development of inclusion and exclusion criteria.

In evaluating titles and abstracts, the following criteria were used, at the first level abstract review, to exclude articles from further consideration.

- article does not include ambulatory or self-measured blood pressure
- article does not include human data
- article not in English
- article contains no original data
- article included $\leq$ 20 patients
- article was a meeting abstract only (no full article for review)
- article does not apply to any of the study questions

A prohibitively large number of citations were deemed eligible for full article review after the initial abstract review. Additional criteria were then applied during a second level abstract review:

- article included $\leq$ 50 patients or article addresses reproducibility and included $\leq$ 20 patients
- article describes cross-sectional/retrospective study, addresses only question #2 or #3, and does not include comparison with clinic measurement
- article describes cross-sectional/retrospective study with outcome other than left ventricular mass or proteinuria/albuminuria
- article addresses only prevalence of dipping versus non-dipping and no other research questions
- article describes clinical trial that does not have longitudinal analysis of clinical outcomes other than blood pressure

Abstract Review Process

For the first level abstract review, titles and abstracts for all articles retrieved by the literature search were printed on an abstract form and distributed to two reviewers. (See Appendix D.) In addition to screening for eligibility, the initial abstract review process was also used to classify the articles by topic. When reviewers agreed that a decision regarding eligibility could not be made because of insufficient information, the full article was retrieved for review.

The results of the abstract review process were entered into the Blood Pressure Citations Database developed in the bibliographic software ProCite. Citations deleted through the abstract review process were tagged with the reason for exclusion. Citations deemed eligible for full article review based on the initial abstract review, were printed onto the second level abstract form (Appendix D) and distributed to two reviewers. For this level of abstract review, when reviewers agreed that there was insufficient information to make a decision regarding eligibility these citations were considered eligible for full article review. As for the first level abstract review, results were tracked in a ProCite database and reasons for exclusion were noted for any citation deemed not eligible for review.

For both levels of abstract review, citations where the reviewers disagreed on eligibility were returned to the reviewers for adjudication.

Article Review

The purpose of the article review was to confirm relevance of each article to the research questions, to determine methodological characteristics pertaining to study quality, and to collect evidence that addressed the research questions. Where articles described more than one study, reviewers were instructed to complete the eligibility assessment (i.e., comparison to inclusion and exclusion criteria), quality assessment and data abstraction for each study separately. For each question, publications of the same information from the same study were also excluded. These apparent duplicate publications were reviewed on a per case basis. Multiple publications were kept if they reported on different results (i.e., different outcomes). Otherwise, the article with a more comprehensive reporting of the data reviewed .

Because of the large number of citations that remained eligible for full article review even after the second level abstract review, additional exclusion criteria were applied at the article review level. The final full list of exclusion criteria differed by question.

Exclusion criteria applied to all articles during article review:

- does not include human data
- not in English
- no original data
- meeting abstract (no full article for review)
- article does not apply to any of the research questions
- article does not include ambulatory or self-measured blood pressure
- article included $\leq$50 patients OR addressed reproducibility and included $\leq$20 patients
- device evaluation was the primary purpose of the study

- study population is exclusively pregnant women
- study population is exclusively children (<20 years of age)
- article addresses research question, but does not present data in an abstractable format
- article addresses only the prevalence of dipping versus non-dipping and no other research questions

Additional exclusion criteria for articles addressing question #1:

- article provided data for clinic blood pressure AND ambulatory blood pressure, or clinic blood pressure AND self-measured blood pressure but did not include a formal within-person comparison of measurements (e.g., no p-value, standard error, standard deviation, confidence intervals or only correlation coefficient(s) provided)
- clinic blood pressure measurement used in analyses was completed on one day only
  The criterion of more than one day of measurement for clinic blood pressure was added because an average clinic blood pressure based on just one day of measurements (typically just one to three readings) is extremely imprecise and could lead to a biased comparison with ambulatory or self-measured blood pressure. This criterion was not applied to articles addressing questions 2-4.

For articles addressing questions #2a and #3a, the following specific exclusion criteria were applied:

- article described cross-sectional/retrospective study and did not include comparison with clinic measurement
- article described cross-sectional study but outcome was not left ventricular mass (by echocardiography) or proteinuria/albuminuria

Several endpoints were considered to compare the ability of clinic, self-measured, and ABP monitoring to assess target organ damage caused by hypertension. Left ventricular mass and protein/albumin excretion were included in the report because they are frequently used in the clinic setting to assess the severity and prognosis of hypertension, they are frequently used in hypertension research studies, and there are standard methods available that may allow for some comparability across studies. Other echocardiographic indices of left ventricular enlargement, such as septal thickness or posterior wall thickness, are not consistently reported, and were not considered in this report. Other markers of target organ damage, such as other echocardiographic determinations of left ventricular function, retinopathy, brain MRI findings, carotid intima-media thickness, were not considered in this report.

Because a relatively small number of articles were expected and the abstraction would be quite different, prospective studies (questions #2b or #3b), studies of reproducibility (question #1 a, b, c) and trials examining the impact of treatment guided by clinic versus that guided by ambulatory (question #3d) or self-measurement (question #2d), were tagged during the initial article review. A separate review was then completed for each of these questions including the following additional or modified exclusion criteria.

For articles addressing reproducibility (#1 a, b, c) the additional or modified exclusion criteria were:

- article included ≤ 20 patients
- article does not include reproducibility of white-coat hypertension.

An initial review of articles did not identify any articles addressing reproducibility of the differences between clinic, ambulatory and/or self blood pressure measurements (question #1a). A separate review form for this question was, therefore, not developed. However, the review form used for articles addressing reproducibility was designed to identify articles addressing reproducibility of differences for future consideration.

Additional exclusion criteria for prospective or longitudinal studies (question #2b or #3b) was outcome not of interest.

For articles concerning effect of treatment guided by ambulatory or self measured blood pressure (question #2d or #3d), the additional criterion applied was non-random allocation of participants.

Quality Assessment and Data Abstraction

Forms were developed to confirm eligibility for full article review, assess study characteristics and to abstract the relevant data to address the study questions. The forms were developed through an iterative process including the review of forms used for previous EPC projects, discussions among team members and experts, and through pilot testing. This process was complex and time consuming due to the heterogeneity of the literature and the diverse questions being addressed.

For the general article review completed initially (for questions #1, #2a, and #3a), three forms were developed and color-coded to aid reviewers and data entry personnel (Appendix E). As necessary, separate forms were created for the three types of studies previously described (i.e., prospective studies (questions #2b or #3b), studies of reproducibility (question #1 a, b, c), and trials examining the impact of treatment guided by clinic versus that guided by self-measured or ambulatory blood pressure measurement (question #3d or #2d)). (See Appendix F).

General Review: Quality Assessment

The first form completed comprised three sections. The first section included the exclusion criteria so that reviewers could confirm the eligibility of the article before proceeding with the full article review. The second section contained a list of each of the study questions allowing reviewers to tag articles by question addressed. This allowed for the identification of articles to be pulled and abstracted separately (e.g., those describing prospective studies). The final section contained questions designed to provide an assessment of study quality. The questions were designed to assess characteristics such as research design and blinding. These questions allowed for the identification of methodological strengths and weaknesses.

General Review: Data Abstraction Part I

The characteristics of the study and baseline information, such as the details concerning the method of BP measurement, were collected on this form.

General Review Data Abstraction: Part II

The specific population characteristics and the results were abstracted using this form. Data were abstracted separately for the whole study population and subgroups by completing multiple forms, as necessary.

Question Specific Reviews

For prospective studies, studies concerning reproducibility of white coat hypertension and trials assessing treatment guided by blood pressure measurement, separate forms were developed as necessary. For prospective studies, the same quality assessment and Part I of the data abstraction form were used. Additional results were abstracted directly into specific fields of a spreadsheet. A separate form was developed for articles addressing reproducibility. For trials, a new quality assessment form was developed, the same Part I of the data abstraction was used, and additional data was entered into a spreadsheet. (See Appendix F for separate forms developed for these articles and for the fields of the spreadsheets.)

Article Review Process

A serial article review process was employed. In this process, the quality assessment and abstraction forms were completed by the primary reviewer. The secondary reviewer, after reading the article, checked each item on the forms for completeness and accuracy. The reviewer pairs were formed to include personnel with clinical and/or methodological expertise. Reviewers were not masked to the article author, institution, or journal. In most instances, data were directly abstracted from the article. If possible, relevant data were also abstracted from figures. In some instances, data were recalculated to meet the specification of the report (e.g., calculation of relative risks from incidence rates).

During the general article review, articles were tagged as to what question(s) they addressed. This process identified those articles requiring separate review (i.e., use of the question specific review instruments).

All information from the general article review process was entered in a relational database (Blood Pressure Evidence Database) via a web-interface. Data from question specific reviews were entered into the Blood Pressure Evidence Database (where same forms completed) or directly into spreadsheets.

Peer Review

Throughout the project, feedback was sought from the technical experts through ad hoc and formal requests for guidance. A draft of the completed report was sent to the technical experts, as well as to the partner, AHRQ, and other peer reviewers. Substantive comments were entered into a database. Revisions were made to the evidence report, as warranted, and a summary of the comments and their disposition was submitted to AHRQ with the final report.

Chapter 3: Results

Literature Search and Abstract Review Process

Results from the searches and the abstract review process were maintained in databases developed in ProCite. A summary of the search results is provided in Table 1. The bulk of the searching was completed in January and February 2001, with a final search of PubMed® completed March 23, 2001. Hand searching of journals was conducted of issues published before May 31, 2001. Hand searching of key references was completed in July 2001.

Of the 6,194 citations retrieved by the search methods, 4,852 were uniquely identified; that is, not previously included in the Blood Pressure Citations database. Of the 4,852 citations, 902 (19 percent) were classified as eligible for second level abstract review. Citations were excluded at this level if they did not address any of the research questions (37 percent), met any exclusion criteria (26 percent) or a combination of the above. Reviewers did not need to agree on what exclusion criterion applied. The most frequent exclusion criterion applied was that the article did not include ABP or SMBP (used by one or both reviewers to delete 1,256 citations). Other major exclusion criteria were a sample size of less than 20 patients (963 citations) and no original data provided (348 citations).

The 902 citations deemed eligible from the first abstract review were imported into a new database and the 35 citations identified by the hand searching efforts were added. Of the 937 citations reviewed at the second level abstract review, 596 (64 percent) were deemed eligible for full article review. As for the first review, the reviewers did not need to agree on a reason for deleting the citation. Of the 341 citations deleted, reviewers agreed that 186 (55 percent) citations included less than 50 patients, that 29 (8 percent) described cross-sectional studies that addressed only question #2 or #3 and did not contain comparison to clinic measurement, that 28 (8 percent) did not address any of the research questions, and that 24 (7 percent) described cross-sectional studies with outcomes other than left ventricular mass or proteinuria/albuminuria. The remainder of the citations were deleted for other reasons or based on a combination of reasons.

Article Review Process

From the abstract review process, 596 citations were identified for inclusion in the article review phase. We were unable to retrieve, and, therefore, unable to complete article review of three articles. [18-20]

Of the 593 articles reviewed, one article described two studies. Each study was assessed and abstracted separately so there were 594 studies for which a review was completed. An initial scan was completed to identify articles with less than 100 patients. These 223 citations were excluded from the general review but were reviewed, as appropriate, for the study questions addressing reproducibility (#1a-c), prediction of clinical outcomes (#2b and #3b – prospective studies) and effect of treatment guided by self or ambulatory blood pressure measurement (#2d and #3d – trials); the minimum sample

size for the reproducibility studies was 20, while the minimum sample size for the prospective studies and clinic trials was 50.

General Review

After the exclusion of 223 articles with under 100 patients, there were 370 articles (representing 371 studies) included in the general review. At the article review level, 252 (68 percent) articles were excluded (representing 253 studies). The primary reasons for exclusion were that the article addressed question #1 only and clinic blood pressure measurement used in analyses was completed on one day only (24 percent of excluded articles) and that the article did not include formal comparison of measurements (14 percent). (See Table 2 for list of exclusions.)

The articles determined to be eligible for review were tagged as addressing the following questions: comparison of readings (question #1) 33 studies, association of SMBP with LV mass or proteinuria/albuminuria (question #2a) one study, and association of ABP with LV mass or proteinuria/albuminuria (question #3a) 27 studies.

As part of the general review process articles were tagged if they addressed issues not being covered in this evidence report and if they addressed any of the other questions being reviewed in separate processes. Articles were tagged as addressing the following issues not included in this review: incremental gain of SMBP (question #2c) (0 studies) or ABP (question #3c) (0 studies) over clinic BP, and the association of dippers with left ventricular mass (six studies) or proteinuria/albuminuria (three studies).

Reproducibility

Thirteen studies were identified through the general review as addressing reproducibility and an additional 50 studies were identified from the articles with less than 100 patients. Most of the 63 studies were excluded (53 studies (84 percent)) as not applicable to the research question which focused on reproducibility of WCH or reproducibility of the difference between ABP (or SMBP) and clinic BP. The vast majority of these studies focused on reproducibility of ABP, SMBP and/or clinic BP. Two studies each were excluded because the study included exclusively children, contained fewer than 20 patients or addressed the prevalence of dipping only. Finally, one study was excluded because data were not presented in an abstractable format. Two studies were identified as addressing reproducibility of white coat hypertension. One study was determined to address reproducibility of the absolute differences between clinic BP and ABP.

Prospective Studies

From the general review, five studies were identified as addressing the prediction of clinical outcomes using self measurement of blood pressure, 25 studies were identified as addressing prediction of clinical outcomes using ambulatory blood pressure measurement. An additional 13 studies were tagged as prospective studies addressing the prediction of clinical outcomes from the articles with less than 100 patients. From the total number of studies (43), 27 were excluded. The reasons for exclusion were: article did not address research question (15 studies), duplicate

publication (five studies), data not presented in abstractable format (four studies), less than 50 patients (two studies), and no outcome of interest (one study).

Trials

From the general review 22 studies were tagged as addressing the effect of treatment guided by SMBP or ABP. An additional seven studies were identified as addressing this issue from the articles with less than 100 patients. From the total number of studies (29), 15 were excluded. The reasons for exclusion were: study not a randomized controlled trial (seven studies), did not address research question (four studies), data not presented in abstractable format (two studies), study population exclusively pregnant women (one study), and study had less than 50 patients (one study).

Description of the Literature

The identified literature addressing BP measurement outside of the office setting was vast and heterogeneous. Most ABP and SMBP studies have been published in specialty journals, primarily those in the field of hypertension. From the 596 articles that were eligible for review, the following journals published ten or more articles (ordered from highest to lowest number of publications): *Journal of Hypertension* (71 articles), *American Journal of Hypertension* (67 articles), *Journal of Human Hypertension* (51 articles), *Hypertension* (48 articles), *Blood Pressure Monitoring* (36 articles), *Journal of Hypertension - Supplement* (33 articles), *American Journal of Cardiology* (11 articles), and *Clinical/Experimental Hypertension* (11 articles). In contrast, publications in general medical journals were relatively uncommon. For example, the *Annals of Internal Medicine* published just two articles, the *Archives of Internal Medicine* five articles, and the *Journal of the American Medical Association* nine articles.

Of these 596 articles, the vast majority of articles (445 articles, 75 percent) were published between 1990 and 1999; 72 articles (12 percent) were published in 2000 or 2001, and another 73 articles (12 percent) between 1980 and 1989. A similar pattern of journal types and of publication years was evident for the articles that were abstracted for this report.

For the majority of the studies, a funding source could not be identified. Approximately 20 percent of studies cited a government source of funding. Of the 89 studies abstracted, 18 percent were completed in the United States, while 54 percent were completed in European countries.

Question #1

Comparison of clinic, ambulatory, and SMBP readings:
Question #1a. What is the distribution of the BP differences between clinic, ambulatory, and SMBP readings?

A total of 18 studies addressed the distribution of BP differences among clinic BP, ABP, and SMBP and met the inclusion criteria, which included a minimum sample size of 100 and a requirement for at least 2 visits of clinic BP measurements. Among these, six studies compared clinic BP and SMBP,[21-26] 12 studies compared clinic BP and ABP,[22,25,27-36] and 3 studies compared SMBP and ABP.[25,37,38] One study compared all three types of BP measurements.[25]

Of the 18 studies, a subset of studies displayed in Evidence Table 1, 10 studies were single center,[21-23,25,27-30,35,38] five were multi-center;[26,31-33,37] in the remaining three studies, the number of centers was unclear.[24,34,36] The source of funding was not reported or was unclear in 13 studies; of those reporting the source of funding, two studies were funded by industry,[33,37] two by government[27,36] and one by both government and industry.[32] Twelve studies provided a basic set of patient characteristics (age, gender, and percent on anti-hypertensive medication). Only three studies documented that the clinic BP observer was trained.[22,30,38] Of the eight studies that obtained SMBP measurements, six studies documented that participants received training in SMBP. Of the 14 studies that obtained ABP measurements, only four studies mentioned that participants received training on how to wear an ABP device.[29,31,36,37] A measure of statistical variability (SE, SD, 95% CI or p-value) was reported in all studies.

The sample sizes ranged from 100 to 1651, and mean age ranged from 33 to 75 years (Evidence Table 2). Most studies either targeted hypertensives as the study population or included them as part of a general population; only two studies excluded hypertensive individuals.[29,35] One study targeted only men.[31] Just one study reported that blacks were included in the study sample.[27]

As displayed in Evidence Table 3, the vast majority of studies measured clinic BP in the seated position. Of the 16 studies that obtained clinic BP, all studies had more than one day of blood pressure measurement (range:2 to 4 days); the total number of measurements ranged from 2 to 12. Eight studies used a mercury devices,[21,22,25,27,29,30,34,35] two studies used automated devices[24,26] and one used an aneroid.[23] Of the 12 studies that reported the type of observer, a physician measured BP in six studies, a nurse in four studies, and a technician in two studies.

Of the eight studies that measured SMBP, all studies used an electronic or automated device to record SMBP except for one study which used an aneroid device.[23] (See Evidence Table 4.) Just three studies used a validated device.[22,25,38] Six studies documented that the patient recorded BP;[22-26,37] in two studies this information was not provided.[21,38] The number of measurement-days ranged from two to 14, while the total number of readings ranged from two to 28. In all instances, BP was recorded in the morning and evening; in two studies patients also measured BP in the afternoon.[21,24]

Fourteen studies compared ABP readings to clinic BP (12 studies) or SMBP (three studies). As displayed in Evidence Table 5, nine studies used a validated device. A majority of studies

used fixed time intervals to define daytime and nighttime ABP; only one study used patient reported times to define awake and asleep ABP.[25]

Six studies compared clinic BP and SMBP (Evidence Table 6). All studies reported lower mean SMBP than clinic BP. The mean differences between clinic BP and SMBP ranged from 5.4 to 17.7 mmHg for systolic BP and from 1.5 to 6.3 mmHg for diastolic BP. All differences were highly significant ($p<0.01$) except for the systolic and diastolic BP differences in one study.[24]

Twelve studies compared clinic BP and ABP (Evidence Table 7 for systolic and Evidence Table 8 for diastolic). For systolic BP, clinic BP exceeded daytime ABP in eight of nine studies (range of differences: -3.8 to 21.9 mmHg, $p<0.001$ in each of eight reports that reported p-values), exceeded nighttime BP in each of three studies (range: 19 to 23.9 mmHg, $p<0.001$ in the two reports with p-values) and exceeded 24 hour ABP in five of six studies (range: -7 to 17 mmHg, $p<0.05$ in the four reports with p-values). For diastolic BP, clinic BP exceeded daytime ABP in each of nine studies (range: 1.9 to 11.8 mmHg, $p<0.05$ in each of six reports with p-values), exceeded nighttime BP in each of three studies (range: 18.9 to22 mmHg, $p<0.001$ in the two reports with p-values) and exceeded 24 hour ABP in each of four studies (range: 3 to 14 mmHg, $p<0.05$ in the four reports with p-values).

Two studies reported gender-stratified analyses.[28,33] For both men and women, clinic BP exceeded daytime and 24 hour BP, but the differences appeared somewhat greater in women than men. The same pattern was evident for both systolic and diastolic BP.

Only three studies compared SMBP and ABP (Evidence Tables 9 and 10). There were no significant differences between SMBP and daytime ABP for either systolic or diastolic BP. In contrast, for both systolic and diastolic BP, SMBP was substantially greater than nighttime ABP in the one study that reported differences and was also greater than 24 hour BP in two studies.

In summary, for both systolic and diastolic BP, clinic BP measurements exceed SMBP, daytime ABP, nighttime ABP and 24 hour ABP. Few studies compared SMBP and ABP levels.

Question #1b. What is the prevalence of WCH as defined by SMBP?
Question #1c. What is the prevalence of WCH as defined by ABP measurement?

We identified 4 studies that determined the prevalence of WCH using SMBP (Evidence Table 11)[21,38,45,52] and 16 articles that determined the prevalence of WCH using ABP (Evidence Table 12).[36,38-51] Two studies included estimates of the prevalence of WCH using both ambulatory and home BP monitors.[38,45] Thus, a total of 18 articles were identified for review. The majority of studies (n = 11) were conducted at a single clinical center, six were multi-center and for one article the category could not be determined.[49] No funding source was identified for 11 studies. Of those for whom a funding source could be identified, four were funded whole or in-part by a government agency[36,40,50,51] and three were funded whole or in-part by industry[43,50,52] and one by a non-governmental, non-industry source.[47] Most studies (n = 14) reported eligibility criteria in enough detail to replicate the study design and 16 provided basic descriptive characteristics of the study population (age, gender, percent on anti-hypertension medications). However, two studies provided insufficient information on eligibility and baseline characteristics of the study population.[36,41] Observers were masked to other modes of BP measurement in 11

studies. Only three studies specifically indicated that observers were trained in the measurement of clinic BP.[38,43,46] Participants were trained in the use of ABP monitors in eight of sixteen studies utilizing ABPM, and trained in SMBP in two of four studies that utilized home monitors. (See Evidence Table 1.)

As shown in Evidence Table 2, the characteristics of the study populations targeted varied considerably across the studies. A minimum sample size of 100 was required for consideration in this review. The largest sample size was 1,414.[47] Most studies recruited participants from hypertension or specialty referral clinics (n = 10). Four studies were conducted among participants drawn from a general medical clinic;[43,50,52,53] for four studies the population from which the study sample was drawn could not be determined.[36,42,47,51] No studies were conducted in settings that could be described as coming from the general population. Because persons with WCH must, by definition, have an elevated clinic blood pressure, all studies targeted persons with hypertension based on clinic BP. Persons taking anti-hypertensive medications were specifically excluded in 11 of the 18 studies identified. All studies included both men and women, with the percent of men ranging from 38-65 percent. No study reported results according to the race/ethnicity of the study population.

In 10 studies, a mercury sphygmomanometer was used to measure clinic BP. (See Evidence Table 3.) For the remainder, the measurement device was not specified. Physicians or nurses were the observers in 10 studies; in the four other studies, the observer of clinic measurements was not specified. According to the inclusion criteria for this question, all reviewed studies had clinic blood pressure measurements taken on more than one day. The total number of clinic measurements included in the analysis ranged from 2 to 9.

In 9 of the16 studies utilizing ABP measurements, a Spacelab monitor was employed. (See Evidence Table 5.) The remainder used a variety of monitors. The definition of "daytime" was not uniform among studies. In 38 percent of studies, the definition of "daytime" could not be determined or was defined by each participant within the study and thus was not standardized for the study population. When specified the start of "daytime" ranged from 6 a.m. to 10 a.m. and the end of "daytime" ranged from 8 p.m. to 12 p.m.

As shown in Evidence Table 4, the Omron 705c automated device was used in three of the four studies utilizing SMBP to define WCH.[38,45,52] In one study, the device was not specified.[21] For two of the four studies, the observer was specified as the participant, and not another individual.[38,52] For the remaining two studies, the observer was not explicitly stated.[21,45] For three of the four studies, both morning and evening blood pressure readings were included. In one study, the time of BP measurement was not stated.[52] All studies used the average of several readings obtained on different days in the analysis.

The definition of WCH differed within and between studies. For studies utilizing ABP (Evidence Table 12), the mean daytime and/or 24-hour BP was used for comparison to clinic BP measurements. Moreover, different cut-points were used within and between studies to define ABP-determined hypertension, as well as clinic-determined hypertension. Three studies [43,47,50]used a common cut-point for ABP-hypertension proposed by Verdecchia, et al.[54] However, the definition of clinic-hypertension was not uniform between studies. Nevertheless, the prevalence of WCH in these three studies ranged from 18.9 percent to 35 percent. Generally, as expected, the higher the cut-point for ABP-hypertension, the lower the prevalence of WCH.

For studies using ABP monitoring as the method for comparison to clinic BP, the prevalence of WCH ranged from 11 percent to 67 percent. The exceptionally high prevalence of WCH seen in the latter study is noteworthy for several reasons.[46] The study sample was composed of persons receiving medication for the treatment of hypertension. Thus, the extent to which individual blood pressure medications and/or their dosing schedules influenced the results is unknown. Moreover, the participants in this study were enrolled from a tertiary referral center for management of drug resistant hypertension, a population that may exhibit a higher prevalence of WCH. Excluding the highest and lowest estimates for the prevalence of WCH, the prevalence of WCH ranged from 11.9 to 39 percent. The largest study estimated the prevalence of WCH at 19 percent.[47] The study that utilized the greatest number of clinic BP measurements (n=9) for use in comparison to ABP estimated the prevalence of WCH at 23 percent.[39] Finally, in each study that presented prevalence estimates by gender, the prevalence of WCH was higher in women compared to men. In one study, the prevalence of WCH was statistically higher in women than in men, but no gender-specific prevalence estimates were provided.[45]

As shown in Evidence Table 11, in studies using SMBP for comparison to clinic BP, the prevalence of WCH ranged from 13 to 33 percent. However, these studies also used different definitions to define both clinic hypertension as well as SMBP. In two of the four studies, WCH as defined by ABP was available for comparison.[38,45] Within each study, the prevalence of WCH as determined by ABP and self- blood pressure monitoring techniques were similar (11 and 13 percent respectively)[38] and (25.9 and 25.9 percent respectively).[45] However, the prevalence of WCH between studies was more disparate (approximately 8 percent versus 26 percent).

In summary, the prevalence of WCH is difficult to ascertain due the lack of standard definitions for both clinic and non-clinic blood pressures. Most studies were relatively small and the populations studied were quite heterogeneous. Nevertheless, the prevalence of WCH from the available evidence is estimated to be between 11 and 69 percent. However, the largest study and the study that utilized the greatest number of clinic blood pressure measurements in its analysis, place the estimate closer to approximately 20 percent. A similar range was observed for WCH as determined by SMBP. Finally, in studies that examined prevalence of WCH by gender, women consistently had a higher prevalence of WCH than men.

Question #1a-c. Reproducibility of differences in readings and WCH

Only two studies provided data on the reproducibility of WCH. One study was a multi-center study [55] and the other was a single center study[56] (Evidence Table 1). Both studies provided eligibility criteria in sufficient detail to replicate the study design. Both studies reported that clinic blood pressure was measured using a standardized technique; however, neither study reported that the observer for clinic BP was trained. For ABP, both studies reported that patients received instructions prior to wearing the ABP device.

Both studies included only untreated hypertensive patients who had previously been identified as having WCH (Evidence Table 2). Only one study provided all three of the basic descriptive characteristics of the study population (age, gender and percent of anti-hypertensive medication).[55] The participants in the study by Palatini et al.[55] were slightly younger than the participants in the study by Verdecchia et al.,[56] 33 years vs. 44.3 years.

As shown in Evidence Table 3, the methods used to assess clinic BP varied across the two studies. In the study by Palatini et al ,[55] the type of device and the type of observer were not reported. One study measured clinic BP in the supine position, [55] while the other measured clinic BP in the sitting position. [56] Both studies assessed clinic BP using more than one day of measurements; however the total number of clinic BP measurements was larger in the study by Palatini et al.[55]

For determination of ABP, both studies used more than one device. As shown in Evidence Table 5, the study by Palatini et al.[55] used the SpaceLabs 90207 and the TM 2420 while the study by Verdecchia et al.[56] used the SpaceLabs 90207 and the SpaceLabs 90202. All of these devices had been validated. Fixed intervals were used to determine daytime and nighttime BP. For daytime BP, the interval between measurements ranged from 10-15 minutes, and for nighttime BP the interval ranged from 15-30 minutes.

The sample sizes of the two studies were similar; the sample size in the study by Verdecchia et al.[56] was 83, while the sample size in the study by Palatini et al. was 90 [55] (Evidence Table 13). For both studies, WCH was determined by clinic BP and ABP; however, these two studies used different definitions of WCH. In the study by Verdecchia et al., WCH was defined as office systolic BP > 140 mmHg and/or diastolic BP > 90 mmHg and ABP < 131/86 mmHg for women or <136/87 mmHg for men.[56] Conversely, Palatini et al. defined WCH as office systolic BP 140-159 or diastolic BP 90-99 and ABP<130/80 mmHg. [55] Additionally, the interval between repeated sets of ambulatory and clinic BP measurements differed substantially between the two studies, three months [55] vs. 2.5 years. [56]

As shown in Evidence Table 13, in the study by Verdecchia et al, 63 percent of the population initially defined as white-coat hypertensive, remained white-coat hypertensive when reassessed 2.5 years later.[56] In the study by Palatini et al, 23.7 percent of the initial population remained white-coat hypertensive when reassessed after three months, while the remaining 76.3 percent became sustained hypertensives.[55]

Question #2

The relationship of mean blood pressure levels and WCH as defined by SMBP to clinical events.

Question #2a. Is SMBP more or less strongly associated with BP-related target organ damage than clinic BP measurements?

Only one study that compared the association of target organ damage with self-measured and clinic blood pressure fulfilled our inclusion criteria.[22] This study described in detail the eligibility criteria and baseline characteristics of study participants, and the study personnel collecting clinic blood pressure measurements were masked to self measurements and to relevant clinical data (Evidence Table 14). In addition, clinic blood pressure measurements were taken by trained personnel using an appropriate cuff size. At least 2 minutes separated clinic BP measurements. The study subjects also received written instructions and individual guidance on how to perform self measurements correctly.

The study was a cross-sectional assessment of newly diagnosed, moderate to severe untreated hypertensives, 35 to 54 years of age, referred to the study clinic from the primary and occupational health services in the metropolitan area of Turku, Finland. The authors screened 252 patients. After excluding patients with coronary artery disease, cerebrovascular disease, insulin-treated diabetes mellitus, significant valvular disease and pregnant women (Evidence Table 15), the authors studied 239 eligible patients and present data on 233 subjects with complete clinic, SMBP, and ABP measurements.

As shown in Evidence Table 16, clinic BP was measured by a trained nurse using a mercury sphygmomanometer, after the patient sat for at least 15 minutes. Clinic BP was recorded twice in each visit, and measurements were obtained at 4 separate visits within 3 weeks. The reported clinic BP was the average of these 8 measurements.

Self-measurements of blood pressure (Evidence Table 17) were performed at home with a semiautomatic oscillometric device (Omron HEM 705C) that has been validated according to the BHS and AAMI standards. The cuff size was selected as a function of the patient's arm circumference. Patients were instructed to follow the same preparations to measure their blood pressure as in the clinic and to have their blood pressure self-measured twice at a 2-minute interval every morning between 6 and 9 a.m. and every evening between 6 and 9 p.m. on 7 consecutive days. The reported self-measured blood pressure was the average of these 28 measurements.

Left ventricular mass was measured by two-dimensionally controlled M-mode echocardiography (Aloca SST-860) and a 3.5 MHz transducer. Measurements were performed according to the American Society for Echocardiography recommendations[58] and the equation developed by Devereaux et al.[59] was used to estimate the left ventricular mass. The average left ventricular mass index (LVMI) of study participants was 111 g/m^2 (SD 25) of body surface area. (See Evidence Table 18).

As shown in Evidence Table 19, the correlation of SMBP with LVMI was greater than that of clinic BP. The correlation coefficients of SMBP and clinic BP with LVMI were 0.47 and 0.44, respectively, for systolic BP, and 0.40 and 0.37, respectively, for diastolic BP. In multivariate stepwise models, gender and home blood pressure were the only significant predictors of LVMI in models that also considered age, gender, clinic, and ambulatory blood pressure measurements.

The same study also compared the association of albuminuria with SMBP and clinic BP. Albumin excretion was determined by nephelometry in 24 h. urine collections. (See Evidence Table 20). The average urinary albumin in the study participants was 25.7 mg/24 hour (SD 39.3). As shown in Evidence Table 21, self-measured and clinic BP showed a similar correlation with log-transformed urinary albumin. The correlations of SMBP and clinic BP with log-albumin were 0.32 and 0.34, respectively, for systolic BP and 0.28 and 0.25, respectively, for diastolic BP.

In summary, only a single study compared SMBP and clinic BP with target organ damage. In this study, SMBP was a better predictor of left ventricular mass than clinic BP. Correlations of albumin excretion with SMBP and clinic BP were similar. Although the study was methodologically sound, the added prognostic information provided by self-measured blood pressure with respect to clinic measurements on target organ damage remains uncertain. No

study compared the levels of target organ damage in normotensives, white coat hypertensives, and sustained hypertensives as determined by self-measured blood pressure.

Question #2b. Does SMBP predict subsequent clinical outcomes?

Two articles, both published from the same prospective observational study, addressed the issue of whether SMBP can predict subsequent BP-related events.[60,61] In one article, the outcome variables were total mortality and CVD mortality.[60] In the other article, fatal and non-fatal stroke was the outcome.[61]

As displayed in Evidence Table 22, the cohort study was a single center study partially supported by government and other sources. The description of eligibility was adequate in both reports, but a complete set of core baseline characteristics (age, gender, percent on medications) was not reported in one article.[61] Participants received training on recording SMBP. Follow-up data were available in greater than 80 percent of participants for both reports.

The cohort study was a population-based survey of adults, ages 40 and older, conducted in one region in Japan. Participants included non-hypertensive persons as well as hypertensive persons, some of whom were on medication (Evidence Table 23). The study did not measure standard BP in the office or clinic setting. Rather, survey staff measured BP at home, using an automated device (Evidence Table 24); hence, for this section, the term 'clinic BP' applies to home measurements by survey staff. Clinic BP was the average of 2 measurements obtained at one visit. Self-measured BP was the average of daily morning measurements recorded over 28 days. The device used for SMBP was not validated according to AAMI or BHS guidelines because baseline data were collected prior to publication of these guidelines. The mean number of measurements contributing to the average SMBP exceeded 20 in both reports. (See Evidence Table 25.)

As shown in Evidence Table 26, the size of the cohort was less than 2000 persons. The difference in sample sizes between the two reports reflects the additional exclusions of prior stroke and atrial fibrillation in one article.[61] Over follow-up, there were 52 CVD deaths, 160 total deaths, and 39 strokes (non-fatal or fatal). Analyses were adjusted for several CVD risk factors (age, gender, smoking, and prior CVD events) but not cholesterol or diabetes. In one paper, risk estimates were presented as the relative risk (RR) per mmHg.[60] In the other paper, the risk estimates were presented for quintiles of BP with different reference categories;[61] hence, risk estimates were re-calculated so that the lowest quintile of BP was the reference group.

Neither clinic systolic BP nor clinic diastolic BP was significantly associated with any of the three outcomes in a progressive, dose-response fashion. However, for stroke, the RRs associated with the highest quintile of clinic systolic and diastolic BP were significant. For SMBP, the RR associated with the fifth quintile of diastolic was significant.[61] In the original publication, the relationship between systolic SMBP and stroke was non-linear, that is, J-shaped.[61] For CVD mortality and for total mortality, systolic SMBP but none of the other BP measurements was significantly associated with these outcomes.[60]

Neither study explicitly tested whether SMBP was superior to clinic BP for predicting outcomes or whether SMBP provided additional prognostic information (incremental gain) beyond that of clinic BP.

In summary, the published literature is insufficient to provide a definitive answer to this research question. The only cohort study that has assessed whether SMBP can predict outcomes documented a linear, progressive relationship of systolic SMBP with total and CVD mortality but a non-linear, J-shaped relationship with stroke. Neither study reported comparative analyses on risk prediction by SMBP and clinic BP.

Question #2c: What is the incremental gain in prediction of clinical outcomes from use of self-measurement devices beyond prediction from clinic BP alone?

Please see discussion for Question #2b.

Question #2d. What is the effect of treatment guided by SMBP in comparison to treatment guided by clinic BP.

A total of 12 trials assessed the effects of SMBP interventions on BP or hypertension control.[62-73] As displayed in Evidence Table 28, one was a multi-center trial, nine were single center trials, and two trials did not provide this information. Seven trials had partial or adequate descriptions of eligibility criteria, only one trial provided a sample size justification, and seven trials had partial or adequate descriptions of the randomization process. Nine trials provided an adequate description of the BP outcome variable, five explicitly stated or had methods that ensured blinding of the outcome, and seven reported between group p-value. In ten trials, participants received training to use SMBP devices, but just five described the approach to adjusting BP therapy based on the SMBP results.

All 12 trials had a parallel group design (eight with two groups, two with three groups, one with four groups, and one with five groups). In nine of the trials, SMBP was the only component of the active intervention arm, except for BP reports to patients and/or physicians in three studies. Other dimensions of the active intervention groups were an activated significant other (trained and encouraged to measure in BP) in one trial, telephone evaluation of adherence in one trial, and a multi-component behavioral treatment program in one trial. Two of the 12 trials used telemetry as part of the active intervention program.[66,70] One trial used ABP as the outcome variable while all others used clinic BP measurements.[70]

The sample size of the trials ranged from 62 to 622. (See Evidence Table 29.) Participants were drawn from a general population in two trials, general clinics in five trials, hypertension clinics in one trial, screening events in one trial, and rehabilitation hospital in one trial; the setting was not specified in one trial. All trials enrolled hypertensive individuals, and three trials focused on individuals with poorly controlled hypertension. Trials typically enrolled both men and women (range of percent men: 22.8 to 98 percent). Five trials reported that blacks were enrolled (range of percent African-Americans in these five studies: 10.5 to 76.2 percent]. Mean age in the trials ranged from 41.2 to 76.5 years.

As displayed in Evidence Table 30, seven trials used an electronic or automated device , two used a mercury manometer and three did not specify the device. In eight trials, the manufacturer and/or specific device was provided. Nine trials provided the frequency of SMBP measurements, which ranged from once per week to three times each day.

The outcome variable in these trials is poorly described (Evidence Table 31). The device used to measure BP is mentioned in just two trials;[62,70] of these, ABP was the BP outcome measurement technique in one trial.[70] Of the 11 trials that did not use ABP, the position of the participant is mentioned in three trials, and the number of days of follow-up measurements is mentioned in six trials. Of these six trials, follow-up BP was measured on just one day in five trials and on three days in the other trial.

The SMBP interventions led to significant changes in BP, either systolic or diastolic BP, in seven trials (reduced BP in six trials[63-66,70,71] and increased BP in one trial[62]). (See Evidence Table 32.) In the other five trials, BP was either unchanged, or the significance test was not reported. In both of the trials that included telemetric transmission of BP, the interventions significantly reduced diastolic BP but not systolic BP.[66,70] Three trials reported or commented on gender differences; in one trial, reductions in BP from the SMBP intervention were similar by gender,[70] while in two studies results were better in women compared to men.[71,73] One trial reported that the SMBP intervention significantly improved mean arterial pressure in blacks.[70]

Initiation and use of medication was reported in three trials. In two trials,[62,68] including the one trial in which BP rose, medication use at the end of follow-up was higher in the control group compared to the SMBP group. In one other trial, medication use was similar.[69] One trial, that included SMBP as well as telemetric transmission of data and a multi-factorial intervention, documented improved adherence in this group.[66] One trial documented that SMBP reduced costs of hypertension care.[71]

The interpretation of SMBP trial results is complex. First, because SMBP is a diagnostic technology used to assist in BP management, the impact of SMBP is indirect, that is, mediated through changes in BP therapies, both pharmacologic and non-pharmacologic. Hence, an evaluation of SMBP must include an assessment of the approach to therapy in both active and control groups. Unfortunately, none of the papers explicitly stated whether and how SMBP guided therapy. Second, SMBP can be used to adjust BP medications for two distinct problems, that is, to improve BP control in those with inadequately controlled hypertension or to reduce the intensity of BP therapy in persons with apparently low BP. Hence, the lack of BP reduction from SMBP in some studies may reflect a mixed effect, namely, downward titration of medications in some patients and upward titration of medications in other patients. Third, while all trials used SMBP, many of the trials combined SMBP with other interventions, often as a means to improve adherence with therapy. Fourth, SMBP technology is undergoing rapid advances that should influence its effectiveness, specifically, the development of integrated systems that not only synthesize SMBP readings but also can transmit reports to patients and physicians with feedback including advice on therapy. While such advances should, in general, improve the utility of SMBP, there is the potential for inadvertently recording and synthesizing data from multiple individuals (e.g., spouse).

In summary, interventions that included SMBP improved BP control in six of 12 trials. In view of major design limitations, particularly suboptimal measurement of the outcome variable, it is possible that additional studies would have documented benefits had they used a more satisfactory outcome measurement technique. Few published trials used contemporary technologies that automatically synthesize SMBP data over time and that allow for telemetric

transmission of SMBP measurements. Of the two trials that used this technology, both documented reduced BP from intervention that included this technology.

Question #3

The relationship of mean levels and WCH as defined by ABP measurement to clinical events. Question #3a. Is ABP more or less strongly associated with BP-related target organ damage than clinic BP measurements?

A total of 27 papers (Evidence Table 33) fulfilled our selection criteria and provided data to compare the association of clinic BP and ABP with target organ damage (left ventricular mass in 22 studies, or urinary albumin/protein excretion in nine studies).[22,30,39,43,47,50,53,74-93] These papers originated from 25 different studies (two studies published their findings in two separate reports each[43,50,53,92]). As in other sections in this report, the percentages describing the evidence will refer to the number of studies rather than the number of papers, unless explicitly indicated. The majority of studies (64.0 percent) were single-center, and 24.0 percent were multicenter. In 12.0 percent of studies, the number of centers involved could not be determined. The source of funding was also unclear for 60.0 percent of studies. Of the nine studies (35.7 percent) that documented a source of funding, five were funded by government, three by industry, and five by other sources (non-exclusive categories).

As shown in Evidence Table 33, most studies (92.0 percent) reported the eligibility criteria with enough detail to replicate the study design, and all studies provided basic descriptive characteristics of the sample participants (gender, age, and percentage of patients on antihypertensive medication). However, limitations in the quality of blood pressure determinations were widespread. For clinic measurements, only four studies (16.0 percent) stated that the persons who took the clinic blood pressure determinations were trained, and only 11 studies (44.0 percent) reported some effort at standardizing the measurement techniques, such as following standard guidelines, using appropriate cuff sizes, or waiting some period of time between repeated measurements. Clinic BP measurements were masked to other study data in 56.0 percent of studies. Only 11 studies (44.0 percent) reported that they had provided some kind of instructions to participants when they wore an ABP device.

The characteristics of the study populations targeted varied considerably (Evidence Table 34). Although all studies included hypertensive patients, most of them (84.0 percent) either excluded patients on anti-hypertensive medications or discontinued treatment for a variable period of time prior to study measurements. Two notable exceptions are the studies by Myers et al.[30] and by Cuspidi at al.[74] that specifically targeted treated hypertensives as part of the study population. The proportion of hypertensives in the studies ranged from 34.6 to 100 percent, with 10 studies (40.0 percent) including only hypertensive participants.

Most studies (60.0 percent) did not report who had taken the clinic blood pressure determinations (Evidence Table 35). Of the 10 studies that reported the observers, six used physicians exclusively, three nurses exclusively, and one physicians and nurses. Among the 16 studies that reported the device used, 14 used mercury sphygmomanometers (two with random zero), one study used an automated device, and one study used multiple devices. All studies

reporting information on the total number of measurements used multiple determinations (ranging from 2 to 9), although no study took more than three measurements per day, and only the study of Jula et al. took them on more than three different days.[22] Only two studies used trained observers, followed a standard technique, and took BP on three or more days.[22,43]

Although there was a wide representation of manufacturers of ABP devices across studies, SpaceLabs devices were most frequently used (Evidence Table 36). Also, most studies (92.0 percent) established a distinction between day and night periods for ABP measurements, usually using fixed time periods (19 studies) rather than periods defined by the patients' activities (4 studies).

A total of 22 studies compared the associations of clinic blood pressure and ABP with LV mass (Evidence Table 37), although the reporting of LV mass determinations differed across studies. If several different measures were available in a study, we abstracted LV mass indexed against the body surface area (16 studies). Five studies indexed LV mass by different powers of height, and the rest used other methods of adjustment for height and/or weight, or did not report the adjustment method. The studies were also highly variable in the criteria for diagnosing left ventricular hypertrophy; in fact, of the six studies that reported these criteria, no two studies shared the same definition. The percentage of patients with left ventricular hypertrophy in these studies ranged from 14 to 36 percent.

The correlation coefficients of LV mass index with clinic BP and ABP were compared in 14 studies (Evidence Table 38). The correlation coefficient of clinic systolic BP with LV mass index ranged from 0.03 to 0.52. In all groups studied the correlation coefficient of 24 hour systolic BP was higher than that of clinic systolic BP, except in men in the study of Martinez et al. [43]and in normotensives in the study of Verdecchia et al. [89] The findings were similar when daytime or nighttime systolic BP, rather than 24 hour systolic BP, were compared to clinic systolic BP, although the correlations of nighttime systolic BP and LV mass index tended to be lower than those of 24 hour or daytime systolic BP.

For each type of BP measurement assessed (clinic, 24 hour, daytime, or nighttime), the correlations of diastolic BP with LV mass index were in general lower than those of systolic BP with LVMI. Twenty four hour diastolic BP correlations with LV mass index were consistently higher than clinic diastolic BP correlations, with the exception of the normotensive group in the study by Schulte et al. [93] Also, daytime and nighttime diastolic BP measurements tended to correlate better with LV mass index than clinic diastolic BP, although not as strongly correlated as 24 hour diastolic BP.

Most studies based the comparisons between clinic and ABP determinations in unadjusted correlations. As noted in Evidence Table 38, studies included different types of determinants in stepwise regression models to elucidate which factor was a more significant determinant of LV mass index. However, substantial differences in statistical methods and the presentation of results precluded firm conclusions. The observed heterogeneity in the use of multivariate modeling methods is partly a reflection of the fact that there is no single "correct" way of modeling these data, and partly a reflection of different modeling objectives in many of the studies (i.e., most studies tried to establish the set of variables with significant associations, while this review was attempting to determine the added value of ABP if clinic BP measures are already in the model).

Ten studies compared the LV mass index of white coat hypertensives with that of normotensives and/or sustained hypertensives (Evidence Table 39). In most of these studies, the cutoffs for clinic hypertension were blood pressures of 140/90mmHg, but the cutoffs for hypertension based on ABP were less consistent. Four studies used 135/85mmHg,[43,77,80,82] one study each used 135/90mmHg,[53] 130/85mmHg,[78] 137/87mmHg,[39] one study used diastolic ABP as cutoffs,[85] and two studies did not report the cutoffs used for defining hypertension on ABP.[30,47] The proportion of white coat hypertensives in these studies ranged from 13.4 to 77.4 percent of participants. Except in the study by Myers et al,[30] sustained hypertensives had higher LV mass index than white coat hypertenvises, with differences of up to 28.3 g/m^2. Likewise, white coat hypertensives had higher LV mass index than normotensives in all studies except in Hoegholm et al.,[53] with differences of up to 26.0 g/m^2. For LV mass, WCH appears to be an intermediate condition between normotension and sustained hypertension.

As shown in Evidence Table 40, the association of ABP with albuminuria was assessed in 9 studies. Six studies used 24 hour samples, one used spot urine samples, one used three 8 hour urine samples, and one study did not report the type of sample collection. Of the eight studies reporting criteria for microalbuminuria, five used 30 mg/24 hour as cutoff.

The correlation of albuminuria with clinic BP versus ABP was compared in 6 studies (Evidence Table 41). The correlation coefficient of clinic systolic BP with albumin excretion ranged from 0.09 to 0.34. In the study of Jula et al.[22] and in the normotensive group of Hoegholm et al.,[92] clinic systolic BP and diastolic BP were more strongly correlated with albuminuria than 24 hour, daytime or nighttime systolic BP and diastolic BP, respectively. In all other subgroups studied, however, ABP measurements were stronger determinants of albumin excretion than clinic BP, often with marked increases in the correlation coefficients. For instance, in the study by Redon et al.,[86] the correlation coefficients for 24 hour ABP (systolic/diastolic) and clinic BP with albumin excretion were 0.34/0.34 and 0.10/0.16, respectively. Overall, protein excretion is more closely associated with ABP than with clinic BP. As with left ventricular mass index, several studies used multivariate models to assess the strongest determinants of albuminuria/proteinuria, but the methodology and the reporting of the models were inconsistent.

Seven papers from five studies compared the albumin/protein excretion of white coat hypertensives with that of normotensives and/or sustained hypertensives (Evidence Table 42). The results of these studies were fairly consistent. In all of them, albumin/protein excretion of sustained hypertensives was significantly higher than that of white coat hypertensives. The differences between normotensives and white coat hypertensives, however, were small, and not significant in all studies except in Martinez et al.[43] While there is a clear impact of sustained hypertension on renal function, the impact of WCH is unclear.

Although the correlation of LV mass and protein excretion with BP tended to be larger for ABP (particularly 24 hour and daytime) than for clinic BP, the poor quality of clinic BP determinations in the majority of studies precludes a satisfactory comparison with clinic BP as recommended by guidelines. The impact of WCH, as determined by ambulatory monitoring, on target organ damage was also evaluated. White coat hypertensives had intermediate levels of LV mass between normotensives and sustained hypertensives as determined by ABP. However, normotensives and white coat hypertensives had similar levels of protein excretion, and only

sustained hypertensives had clearly elevated values. These studies were also limited by the poor overall quality of clinic BP measurements, and by the lack of adjustment for potential confounders when comparing normotensives, white coat, and sustained hypertensives.

Question #3b. Does ABP predict subsequent clinical outcomes?

A total of 14 articles from 10 prospective observational studies addressed the issue of whether ABP can predict subsequent BP-related events.[32,94-106] Of the 10 studies, one study published three articles that covered different aspects of this research question,[98-100] two other studies each published two relevant articles,[32,95,104,105] and the remaining seven studies published only one article. Unless otherwise stated, this section will report and enumerate by 'study' rather than by 'article'.

As displayed in Evidence Table 43, all of the studies were single center except for one multi-center study.[32,95] Government partially funded three studies (corresponding to six articles); in all other instances, the source of funding was uncertain. In seven studies, there was an adequate description of eligibility criteria. A complete set of core baseline characteristics (age, gender, percent on medication) was reported in each study. In terms of clinic BP measurements, only one article documented that the clinic BP observer was trained,[103] only 3 studies documented that the clinical observer was masked to other BP measurements,[32,95,98-100,104,105] and only four studies documented use of standard measurement technique.[94,99-102] Only two articles mentioned that participants received training on how to wear an ABP device.[94,106] Outcome ascertainment was masked in only three studies.[32,95,98-100,104,105] Follow-up data were available on greater than 80 percent of participants in all but one study,[97] and a measure of statistical variability (SE, SD, 95% CI or p-value) was reported in all studies.

The sample size in the studies ranged from 57 to 2010; in eight studies, the sample size was greater than 1000 persons (Evidence Table 44) . One study enrolled hemodialysis patients;[94] another study enrolled type 2 diabetics.[97] In the other studies, the participants were drawn from unselected populations, clinical trial participants, or drawn from general medical clinics and/or hypertension clinics. Except for one study,[101] the mean age was greater than 50 years; two studies focused on older aged individuals.[32,95,103] All studies included both genders (range of percent men: 29.1 to 63 percent). None reported enrollment of African-Americans. Several studies focused exclusively on hypertensive individuals. In one study that reported observational analyses within a placebo-controlled trial, only those assigned to placebo were used in analyses.[32]

All but one study documented the type of ABP device that was used.[97] A SpaceLabs device was used in six studies,[32,94,95,102,104-106] a Diasys device in one study,[96] a Nippon Colin device in two studies,[98-100,103] and a Remler device in one study.[101] Accordingly, the most common technique to record BP was oscillometric. In six studies, the ABP devices had been validated according to criteria of the BHS or the AAMI.[32,94-96,102,104-106] In three other studies, the devices had undergone validation studies prior to widespread use of the BHS or AAMI criteria.[98-101,103] In most studies, a fixed time period was used to define 'daytime' and 'nighttime' BP, while in one study,[98-100] 'awake' and 'asleep' were defined by actual participant reports. The interval between

readings ranged from 15 to 30 minutes (4 readings to 2 readings per hour) for daytime BP and from 15 to 60 minutes (4 readings to 1 reading per hour) for nighttime BP.

Limited information is available on the type and number of clinic BP measurements. Four of the ten studies did not provide any information on clinic measurements.[94,96,97,106] Of the remaining six studies, four used a mercury device,[94,101,102,104,105] one used an automated device,[98-100] and one additional study did not mention the type of device.[95] In four studies, the type of observer was mentioned; a technician or nurse measured clinic BP in three studies, while a physician measured BP in one study.[104,105] Clinic BP was recorded on just one day in three studies[98-100,103-105] and on three days in another three studies.[32,95,101,102] In these six studies, the total number of BPs contributing to average clinic BP ranged from two to nine. In one study, 'clinic' BP measurements were taken at home by medical personnel.[98-100]

As displayed in Evidence Table 45, the outcomes of interest included total mortality (four studies[32,98,99,106]), CVD mortality (four studies[32,94,98,99]), CVD morbidity and mortality (nine studies [32,95,96,101-106]), stroke (three studies[32,95,100]), dialysis (one study[97]) and cardiac morbidity and mortality (one study[32]). The period of follow-up ranged from 1 to 6.4 years. The number of clinical events ranged from 4 to 120. In 11 reports, analyses were adjusted for potential confounders; however, the methods and extent of adjustment procedures varied considerably across reports and occasionally within the same report.

Evidence Tables 46 and 47 present risk estimates as the relative risk, or hazard ratio, of the outcome by change in BP (a continuous variable, mmHg) or by category of BP. Cutpoints for the categories of BP were conventional cutpoints (e.g., systolic BP of 140 mmHg), convenience values, or values of the BP distribution (e.g., quintiles). For this report, the reference category was the lowest level of BP. Because these studies commonly displayed risk relationships in other formats, relative risk estimates were, in several instances, calculated from data presented in the articles,[95,99,101,104,106] including an article in which the reference category was not the lowest BP category.[99]

As displayed in Evidence Tables 46 and 47, a total of eight prospective studies (nine articles) reported the relationship between absolute levels of systolic ABP and subsequent outcomes,[32,94,96,99-103,105] while four studies (five articles) reported corresponding relationships for diastolic ABP.[94,99-101,103] For systolic BP, at least one study outcome was significantly related to clinic BP in two of five articles,[101,105] to daytime ABP in four of seven articles,[32,100-102] to nighttime ABP in four of five studies,[32,94,100,103] and to 24 hour ABP in five of six articles.[32,96,100,103,105] For diastolic BP, at least one study outcome was significantly related to daytime ABP in two of five articles,[100,101] nighttime ABP in two of four articles, [100,103] and 24 hour ABP in one of three articles.[103] Clinic diastolic BP was significantly associated with outcomes in the anticipated direction in one of five studies[101] and in an inverse direction in another study;[94] the latter finding may have resulted from the study population, namely, dialysis patients in whom a lower diastolic BP may be related to excess risk. Overall, absolute level of ABP (mean daytime, nighttime or 24 hour BP, systolic or diastolic) predicted outcomes in each of eight studies that examined this issue, while clinic BP predicted outcomes in two of five studies.

Three articles from two prospective studies examined WCH as a predictor of outcomes (Evidence Table 48).[95,104,105] Both studies documented that the risk associated with WCH was

less than that of sustained hypertension. In one of these studies, the risk associated with WCH was similar to that of non-hypertensives.[104]

Six articles from five studies examined dipping status as a predictor of outcomes (Evidence Table 48). In each instance, the reference category was dippers (that is, those with the usual pattern of lower nighttime BP than daytime BP). In both studies that examined the risk associated with reversed or inverse pattern (that is, higher nighttime than daytime BP), this pattern was associated with a significantly greater risk of outcomes than that of dippers.[97,98] A non-dipping BP pattern (that is, lack of nighttime BP reduction) was associated with a significantly increased risk of outcomes in three of four studies. In one study, non-dipping was a significant predictor of BP events in women but not in men.[104]

The findings are summarized by type of outcome for each potential predictor (clinic BP; daytime, nighttime and 24 hour ABP; WCH and non-dipping status) in Table 3.

Nine of 14 articles compared prediction of outcomes by ABP to prediction by clinic BP. Of these nine studies, just two studies[32,101] assessed 'incremental gain', that is, whether ABP provided additional information that was predictive of risk beyond that of clinic BP. To assess incremental gain, one study used a residual method to determine whether ABP predicted the residual variance left after regression of outcomes on clinic BP,[101] and one presented regression analyses with both clinic BP and ABP in the same model.[32] The other seven studies compared prediction by clinic BP and ABP without determining whether ABP provided additional information beyond clinic; of these, six studies used stepwise regression techniques[97,99,100,102,103,105] and one used discriminant function analyses.[96] ABP was a better predictor of outcomes than clinic BP in each of the seven studies that compared prediction of outcomes by clinic BP and ABP. In the two other studies, ABP provided incremental gain in information beyond that of clinic BP.

In summary, ABP predicted BP-related clinical outcomes. In each of ten prospective studies (14 articles), at least one dimension of ABP predicted one or more clinical outcomes. Absolute ABP levels (mean daytime, nighttime or 24 hour BP, systolic or diastolic) predicted outcomes in each of eight studies, WCH predicted a reduced risk of outcomes compared to sustained hypertension in each of two studies, and non-dipping or inverse dipping predicted an increased risk in four of five studies.

However, available data were insufficient to compare prediction of outcomes by ABP and clinic BP. Absolute clinic BP levels predicted outcomes in two studies in the anticipated direction, in one study in an unanticipated opposite direction, and did not predict outcomes in two other studies; five studies did not report whether clinic BP predicted outcomes. Although ABP was a better predictor of outcomes than clinic BP in most studies and even provided 'incremental gain' in outcome prediction in two studies, measurement of clinic BP and the types of comparative analyses were suboptimal. Hence, it is unclear whether the apparent superiority of ABP over clinic BP resulted from a better estimate of usual BP from ABP or a suboptimal measurement of clinic BP.

Question #3c. What is the incremental gain in prediction of clinical outcomes from use of ambulatory devices beyond prediction from clinic BP alone?

Please see discussion regarding Question #3b.

Question #3d. What is the effect of treatment guided by ABP in comparison to treatment guided by clinic BP.

Two trials, both of which were multi-center studies, tested whether BP management guided by ABP has similar effects on BP and other outcomes in comparison to management guided by clinic BP.[107, 108] (See Evidence Table 49.) In each trial, the eligibility criteria, the approach to BP therapy, and the description of the BP outcome were adequately described; in both studies, the between group p-values were provided. In one study, the description of randomization was adequate, and blinding of the outcome assessors was explicitly stated.[107] Neither study reported whether participants received instructions on how to facilitate ABP measurements.

Both trials were conducted in Europe, one in Germany[108] and the other in several European countries.[107] The sample size in the trial by Schrader was 1298 with a mean follow-up period of 56.4 months,[108] while the sample size in the trial by Staessen was 419 with a median follow-up period of 6 months.[107](See Evidence Table 50.) Both studies enrolled men and women with hypertension; the mean age was over 50 years in both studies. In both studies, mean baseline systolic BP exceeded 160mmHg.

Both trials used ABP to titrate medications, that is, either increase medication use if BP was inadequately controlled or decrease medication use if BP was below the target range. Both trials explicitly described the schedule of BP measurements, the medications used to control BP, and the BP thresholds used to titrate medications. In the trial by Schrader, ABP was obtained annually and in the setting of elevated clinic BP; in the control group, clinic BP was measured one, three, nine and 12 months after randomization and then annually. In Schrader's trial, the thresholds for increasing medications were clinic BP > 140/90mmHg in the control group and daytime BP >135/85 mmHg in the ABP group. In the trial by Staessen, BP in each group was measured at one, two, four and six months after randomization; the target range was a diastolic BP of 80 to 89 mmHg in each group. (See Evidence Table 51.)

In the trial by Schrader, follow-up clinic BP was obtained in both groups (the average of six readings, that is, three readings one each of two days).[108] In the trial by Staessen, both clinic BP and ABP were outcomes; in this trial, clinic BP was the average of three readings obtained on one day.[107](See Evidence Table 52.)

In both trials, there were non-significant increases in clinic BP in the ABP group, net of change in the control group (Evidence Table 53). In the trial by Staessen, which also reported the effects on ABP as an outcome variable, the ABP group had significantly higher 24 hour systolic BP, 24 hour diastolic BP and daytime systolic BP (Evidence Table 54).

In both trials, ABP was used to titrate medications in a fashion that would lead to more aggressive use of medications in persons with elevated ABP and less aggressive medication use in persons with apparently low ABP. In the trial by Staessen, there was less use of medications in the ABP group compared to control group, while in the trial by Schrader medication use was similar, perhaps as a result of enrollment procedures. Specifically, in this trial, persons with WCH were excluded post-randomization in the ABP group but not the control group. Had these

individuals with WCH been included in both groups, not just the control group, overall medication use might have been less in the ABP group.

During follow-up, BP related end-organ disease, as assessed by LV mass, was similar in the ABP and control groups in the trial by Staessen. In the trial by Schrader, clinical cardiovascular events and deaths were less common in the ABP group than the control group, despite similar mean levels of clinic BP in both groups. This pattern of findings occurred despite the fact that the ABP group in this trial was enriched with a relatively high risk group, sustained hypertensives, while the control group included 'white coat hypertensives'. The reduction in clinical cardiovascular events in the ABP group may have resulted a differential approach to persons with high ABP, specifically, those in the ABP group received upward titration of medications whereas those with high ABP remained undetected in the control group.

In summary, the availability of just two trials limits inferences about the utility of ABP to guide BP management. The dearth of studies might be related to several factors, including historical lack of reimbursement for ABP, difficulties in obtaining repeat ABP, and the perception that SMBP is a more suitable alternative to ABP for management. Still, it is noteworthy that there was no apparent excess in BP-related end organ damage in both trials and potentially even a reduction in clinical events, despite the fact that BP medications were sometimes titrated downward.

Question #4

Does the evidence for the above questions vary according to a patient's age, gender, income level, race/ethnicity, and clinical subgroups?

As discussed previously, the vast majority of studies included both men and women. However, few studies reported results separately by gender. Also, studies rarely documented enrollment African-Americans; accordingly, race-stratified data was extremely unusual. The remainder of this section documents reports of individual studies that provided subgroup findings. Except for the prevalence of WCH, it is impossible to draw distinct conclusions for separate subgroups.

Research Question 1

One study reported differences between SMBP and clinic BP by gender.[26] For both systolic and diastolic BP, clinic BP was greater than SMBP in women and men. Another two studies reported BP differences between ABP and clinic BP, separately by gender.[28,33] For both men and women, clinic BP exceeded daytime and 24 hour BP, but the differences appeared somewhat greater in women than men. The same pattern was evident for both systolic and diastolic BP.

The only apparent subgroup difference was the prevalence of WCH by gender. Specifically, in each study that presented WCH prevalence estimates by gender, the prevalence of WCH was higher in women compared to men.[39,40,43,49,51,53]

Research Question 2

No observational study presented SMBP risk relationships separately by gender. In contrast, three trials that evaluated the effects of SMBP reported or commented on gender differences. In one trial, reductions in BP from the SMBP intervention were similar by gender,[70] while in two studies results were better in women compared to men.[71,73] One trial reported that the SMBP intervention significantly improved mean arterial pressure in blacks[70]

Research Question 3

In one cross-sectional study,[43] correlations of left ventricular mass with BP appeared higher in women than in men. In the same study, left ventricular mass in sustained hypertensives was greater than that of individuals with WCH, for both men and women. In one prospective study,[104] non-dipping status was significantly associated with a greater risk of CVD morbidity and mortality in women but not in men.

Chapter 4: Conclusions

Summary of Findings

❑ **Key question 1. Comparison of clinic BP, SMBP, and ABP readings.**

- ***Question 1a. Distribution of BP differences***.
  A total of 18 studies addressed the distribution of BP differences. BP levels measured outside the clinic setting differed from those obtained in the clinic. For both systolic and diastolic BP, clinic measurements exceeded SMBP, daytime ABP, nighttime ABP and 24 hour ABP. In the few studies that compared SMBP and ABP, daytime ABP and SMBP appeared similar, while nighttime ABP was consistently lower than SMBP. The literature was insufficient to determine whether these BP differences are reproducible.
- ***Question 1b. Prevalence of WCH based on SMBP***.
  A total of four studies addressed this issue. Hence, the literature was insufficient to determine the prevalence of WCH by SMBP.
- ***Question 1c. Prevalence of WCH based on ABP***.
  A total of 16 studies addressed this issue. Prevalence varied by WCH definition and study population. Overall, the prevalence was approximately 20 percent among patients with hypertension. Only two studies addressed the reproducibility of WCH. Hence, the literature was insufficient to determine whether WCH based on ABP is reproducible.

❑ **Key question 2. The relationship of SMBP levels and WCH based on SMBP with target organ damage and clinical outcomes.**

- ***Question 2a. Cross-sectional associations of SMBP with target organ damage.***
  Only one study addressed this issue. Hence, the literature was insufficient to determine the associations of absolute SMBP levels or WCH as determined by SMBP with left ventricular mass or proteinuria.
- ***Question 2b. Associations of SMBP with clinical outcomes in prospective studies.***
  Only one study addressed this issue. Hence, the literature was insufficient to determine whether absolute SMBP levels or WCH based on SMBP predicts subsequent CVD.
- ***Question 2c. Comparison of risk prediction from SMBP and clinic BP.***
  Only one study addressed this issue. The dearth of studies combined with the poor or uncertain quality of clinic BP measurements precluded an answer to this question.
- ***Question 2d. Effect of treatment guided by SMBP.***
  Twelve trials addressed this issue, but the evidence was inconsistent. In half of these trials, interventions that included SMBP led to reduced BP. Two trials used contemporary SMBP technology which can store and synthesize SMBP measurements and which can generate BP reports. In both of these trials, the SMBP intervention led to reduced BP.

❑ **Key question 3. The relationship of ABP levels and WCH based on ABP with target organ damage and clinical outcomes.**

- ***Question 3a. Cross-sectional associations of ABP with target organ damage.***
  A total of 25 studies addressed these issues. Left ventricular mass and albuminuria were positively associated with ABP.
- ***Question 3b. Associations of ABP with clinical events in prospective studies.***
  A total of 10 studies addressed this issue. In each study, at least one dimension of ABP predicted subsequent clinical events, primarily CVD. In two of these studies, WCH was associated with a reduced risk of CVD relative to the risk associated with sustained hypertension. No prospective study adequately compared the risk associated with WCH relative to the risk associated with non-hypertension. In four of five studies, a non-dipping or inverse dipping pattern predicted an increased risk of adverse events.
- ***Question 3c. Comparison of risk prediction from ABP and clinic BP.***
  A total of nine prospective studies addressed this issue, but only two studies assessed 'incremental' gain, that is, whether ABP provided additional information that was predictive of risk beyond that of clinic BP. However, the poor or uncertain quality of clinic BP measurements precluded a satisfactory comparison of risk prediction from ABP and clinic BP.
- ***Question 3d. Effect of treatment guided by ABP.***
  Only two trials addressed this issue. Hence, the literature was insufficient to determine the effects of treatment guided by ABP.

❑ **Key question 4. Findings to research questions 1-3 in subgroups.**
The vast majority of studies included both men and women, but few studies reported results separately by gender. Few studies reported enrollment African-Americans, and race-stratified data were rarely presented. The only notable subgroup finding was a higher prevalence of WCH in women than men.

In summary, ABP levels and ABP patterns were associated with BP-related target organ damage in cross-sectional studies. Likewise, in prospective studies, higher ABP, sustained BP and a non-dipping ABP pattern were associated with an increased risk of subsequent CVD events. Few studies examined corresponding relationships for SMBP. The poor or uncertain quality of clinic BP measurements precluded satisfactory comparisons of risk prediction based on ABP or SMBP with risk prediction based on clinic BP. In aggregate, these findings provide some support for use of ABP monitoring in evaluating prognosis. However, evidence was insufficient to determine whether the risks associated with WCH are sufficiently low to consider withholding drug therapy in this large subgroup of hypertensive patients. For SMBP, available evidence from several trials suggested that use of SMBP can improve BP control; however, further trials are needed.

Limitations of Report

The potential scope of the project was beyond available resources. Hence, the EPC team made considerable efforts to focus on the most critical research questions, the most relevant populations, and the most important data collection items. In the process, certain research issues were not covered in this report, for example, the prevalence of non-dipping and its cross-sectional associations. By necessity, the EPC team focused on study populations that are now considered candidates for ABP and SMBP monitoring, that is, non-pregnant adults with hypertension.

The literature review was limited to articles published in English, thus increasing the potential for publication bias. The exclusion of articles not published in the English language reflects the practical realities of obtaining and reviewing non-English articles within the time frame and budget of this project.

The evaluation of diagnostic technologies is complex and often does not lend itself well to the traditional table-based format of an evidence report that synthesizes data from large numbers of basically similar studies, often clinical trials. Furthermore, technologies under evaluation rapidly change such that research is often dated by the time it is completed. In the case of SMBP, only two studies tested contemporary technologies that are capable of storing and transmitting data and generating reports. Finally, it is often unclear whether findings from studies of specific devices can be extrapolated to an entire class of devices.

Another set of issues pertain to the reference technology or 'gold standard' against which new technologies are compared. For this report, a critical issue was whether the standard should be clinic BP as recommended in guidelines or clinic BP as commonly (and sub-optimally) obtained in routine medical practice. In the end, most publications provided little information about clinic BP measurements; hence, it is doubtful that ABP and SMBP were compared to high quality clinic measurements. However, the uncertain or poor quality of clinic BP in these studies may actually parallel its routine use in medical practice.

Limitations of Literature

The ABP and SMBP literature is vast, heterogeneous and poorly indexed. These aspects of the literature created enormous logistic challenges at each point in the process, including the review of 4,852 abstracts, review of 596 articles, the design of appropriate data collection instruments, the abstraction of data, and the construction of evidence tables. In several instances, summary statistics had to be recalculated in order to present data in a common format. Because of heterogeneity in study design and data presentation, results from prospective observational studies and clinical trials were entered directly into separate databases or spreadsheets and into open fields rather than as fixed pre-coded fields.

The quality of publications and presentation of data were often suboptimal. In many instances, core methods and basic descriptive information were presented in an unusual fashion that complicated data abstraction. Likewise, statistical analyses were often suboptimal. In the end, several studies that addressed our research questions could not be included because data were not presented in an abstractable format.

Most studies were single center studies, often with small sample size and without government support. Despite the vital importance of accurate BP measurement, governments have sponsored relatively little research that compares the utility of different techniques.

In most papers, the methods sections provided an incomplete description of clinic measurements. Often the type and training of the manual observer, the type of device, the number of measurement days, the number of BP readings per day, and the use (or non-use) of standard measurement techniques was not reported. When standard BP technique was reported, the measurement was often the average of a few readings, sometimes just one or two from a single visit. Training of manual observers was rarely mentioned. Despite this limitation, it should be recognized that the poor and uncertain quality of clinic measurements likely reflects actual clinical practice, in which high quality clinic BP measurements may never be routinely obtained. In contrast, ABP measurement technique in clinic practice is likely to be similar to that of the research setting.

Other limitations of the literature were evident, including the following:

- Of the available prospective observational studies, most were comparatively small. ABP and SMBP have not been used in the major observational studies that documented the relation between BP and CVD risk.
- Few studies assessed the relation between SMBP and either prevalent BP-related target organ damage (cross-sectional studies) or clinical outcomes (longitudinal studies).
- Few trials assessed the utility of ABP to guide BP therapy.
- Few studies assessed the reproducibility of the diagnosis of WCH or the reproducibility of differences between clinic BP and either ABP or SMBP.
- In the trials that evaluated the utility of SMBP measurements, it is unclear how SMBP data were used to guide BP therapy.
- Few studies have compared SMBP and ABP as predictors of outcomes or as tools to guide BP management.
- Definitions of ABP variables, such as WCH, were exceedingly variable.
- Few studies tested for incremental gain from use of ABP, that is, the gain from concomitant use of ABP with clinic BP beyond that of clinic BP alone. The appropriate analytic model would be simultaneous inclusion of both ABP and clinic BP in regression models rather than stepwise analyses. This proposed analytic strategy would actually parallel the intended use of ABP in clinic practice because ABP would likely be used with clinic BP, not by itself. Specifically, the decision to use ABP and the interpretation of subsequent data is contingent upon clinic BP readings.
- Adjustment procedures were often inadequate leading to the potential for residual confounding

Use of Evidence Report

This report synthesizes evidence that should facilitate clinical decision making and inform policy makers about the utility of BP measurements outside of the clinic setting. The importance of this report is heightened by concurrent concerns and uncertainties over standard clinic measurements. The EPC team intends to disseminate this report through several venues. The

full report will be available through AHRQ's Publications Clearinghouse and its Web Site. Condensed versions of key components will be submitted for publication in peer-reviewed publications that are widely read by physicians and other health care providers who manage patients with hypertension. The NHBPEP will also assist in dissemination of this report through its ongoing activities and meetings. Key findings will also be presented at national meetings of major professional organizations, including the American Society of Hypertension and the American Heart Association. The EPC team anticipates that this report will be used by policy makers who are presently evaluating alternative strategies to measure BP and considering an appropriate research agenda. This report might also stimulate development and dissemination of guidelines for better reporting of ABP and SMBP studies.

Chapter 5: Future Research

The optimal approach to measure BP remains uncertain. In view of the high prevalence of uncontrolled hypertension, the continuing epidemic of BP-related diseases and the potential for alternative measurement techniques to improve diagnosis and target therapy, there is a need for comparative studies that assess the relative efficacy, feasibility, and costs of ABP, contemporary SMBP technology, and clinic BP. Specific types of research needs are as follows:

- ❑ Prospective observational studies that include SMBP, ABP and clinic BP. Specific research questions include:
  - What is the reproducibility of WCH?
  - What are the risks associated with WCH? In particular, is the risk associated with WCH sufficiently low to justify non-treatment? If yes, in what patients?
  - Does WCH as assessed by SMBP carry the same risk as WCH as assessed by ABP?
  - What are the risks associated with non-dipping status?
  - Is non-dipping status a surrogate for some other variable that might be measured more easily, that is, without ABP?
  - What is incremental gain from use of SMBP or ABP over clinic BP alone?
  - Can ABP and SMBP identify candidates who respond to lifestyle modification?
- ❑ Clinical trials that test whether contemporary SMBP technology, compared to conventional management by clinic BP, can improve BP control and health outcomes. An additional comparison group might include BP management by ABP. These trials should also compare the aggregate costs of these approaches.
- ❑ Decision analyses that determine the costs and effects of strategies that integrate clinic BP, SMBP and ABP. These decision analyses should also identify key parameters (probability, utility, or cost) that are the strongest determinants of the relative cost-effectiveness of different strategies. The importance of this research is highlighted by high prevalence of WCH and the potential for cost savings from reduced medication use or side effects, or conversely, the potential for increased CVD events if medications are inappropriately withdrawn. Subsequent research should then focus on the key parameters for which we need more information before drawing firm conclusions about the most cost-effective strategy. In the end, such analyses could guide policy makers in developing algorithms that incorporate, if appropriate, these techniques.
- ❑ Synthesis of evidence on BP measurements in a clinic setting, including issues related to the accuracy and performance of different devices (mercury, aneroid, automated BP) and different observers (physicians, nurses, technicians).
- ❑ Feasibility studies that assess the performance of ABP and SMBP in routine use, including for example, an evaluation of self-reporting bias of SMBP measurements.

In this research, clinic BP should be measured appropriately by trained observers using validated equipment; clinic measurements should also be obtained at several visits. Also, because of the dearth of large-scale, high-quality studies, there is a clear need for government sponsorship of key studies.

To improve the quality of ABP and SMBP publications, standardized methods should be disseminated to researchers and authors. Also, journals should require standardized approaches to presenting ABP data. For published articles, full copies of protocols should be made available, perhaps on the Web. This is especially important because the intense pressure from editors to shorten manuscripts is typically accomplished through reductions in the methods section.

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Evidence Tables Index

Evidence Table 1: Summary of quality characteristics for articles addressing question #1a-c

Study (question)	Center	Funding	Adequate Description		Clinic BP Observer			Self BP Instructions Provided	Ambulatory BP Trained	Statistical Variability Reported
			Eligibility	Baseline Characteristics	Trained	Blinded	Standard Technique			
Abe, 1987(a, b)	single	can't tell	N	Y	can't tell	N	N	can't tell	NA	Y
Aylett, 1999 (b)	multi	industry	Y	Y	can't tell	N	can't tell	Y	NA	N
Helmers, 2000 (c)	multi	govt	Y	Y	can't tell	Y	can't tell	NA	can't tell	Y
Hoegholm, 1999 (c)	multi	can't tell	Y	Y	N	Y	N	NA	can't tell	Y
Inden, 1998 (c)	single	can't tell	Y	Y	can't tell	N	can't tell	NA	Y	N
Ironson, 1989 (a)	single	govt	Y	Y	can't tell	N	Y	NA	can't tell	Y
Jula, 1999 (a)	single	can't tell	Y	Y	Y	Y	Y	Y	can't tell	Y
Khoury, 1992 (a)	single	can't tell	N	N	can't tell	Y	can't tell	NA	can't tell	Y
MacDonald, 1999 (c)	single	govt, other	Y	Y	can't tell	Y	Y	NA	can't tell	Y
Manning, 1999 (c)	single	can't tell	Y	Y	can't tell	Y	Y	NA	Y	Y
Martinez, 1999 (c)	multi	industry	Y	Y	Y	Y	Y	NA	Y	Y
Martinez, 2001 (c)	multi	govt, industry	Y	Y	can't tell	Y	Y	NA	Y	Y
Mengden, 1991 (a)	single	can't tell	N	N	can't tell	N	N	Y	NA	Y
Modesti, 1994 (a)	single	can't tell	Y	Y	can't tell	N	Y	NA	Y	Y
Myers, 1995a (c)	single	can't tell	N	Y	Y	N	Y	NA	can't tell	Y
Myers, 1995b (a)	single	can't tell	Y	Y	Y	Y	can't tell	NA	can't tell	Y
Narkiewicz, 1995 (a)	multi	can't tell	Y	Y	can't tell	N	Y	NA	Y	Y
Nielsen, 1986 (a)	can't tell	can't tell	N	N	can't tell	N	N	Y	NA	Y
Owens, 1999 (c)	single	other	N	N	can't tell	Y	Y	NA	Y	Y
Palatini, 1998 (c)	multi	can't tell	Y	Y	can't tell	N	Y	NA	Y	Y
Pierdomenico, 1995 (c)	single	can't tell	Y	Y	can't tell	N	Y	NA	Y	Y

Study (question)	Center	Funding	Adequate Description		Clinic BP Observer			Self BP Instructions Provided	Ambulatory BP Trained	Statistical Variability Reported
			Eligibility	Baseline Characteristics	Trained	Blinded	Standard Technique			
Sega, 1994 (a)	multi	other	Y	N	can't tell	N	Y	Y	Y	Y
Staessen, 1999 (a)	multi	govt, industry	Y	Y	can't tell	N	can't tell	NA	can't tell	Y
Stergiou, 1998a (a)	single	can't tell	Y	Y	can't tell	N	Y	Y	Y	Y
Stergiou, 1998b (b, c)	single	can't tell	Y	Y	can't tell	N	Y	Y	can't tell	Y
Stergiou, 2000 (b, c)	single	can't tell	Y	Y	Y	Y	Y	can't tell	can't tell	Y
Thijs, 1996 (a)	multi	industry	Y	Y	can't tell	N	can't tell	NA	can't tell	Y
Tochikubo, 1999 (c)	single	can't tell	Y	Y	can't tell	Y	can't tell	NA	can't tell	Y
Verdecchia, 1992 (c)	single	can't tell	Y	Y	can't tell	Y	Y	NA	can't tell	Y
Verdecchia, 1995 (c)	multi	other	Y	Y	can't tell	N	can't tell	NA	can't tell	Y
Verdecchia, 1996 (c)	single	can't tell	Y	N	can't tell	N	Y	NA	Y	Y
Weisser, 1994 (a)	multi	can't tell	N	Y	can't tell	N	N	Y	NA	Y
Zachariah, 1988 (a)	can't tell	can't tell	N	Y	can't tell	N	Y	NA	can't tell	Y
Zachariah, 1991(a)	single	can't tell	N	N	can't tell	N	Y	NA	can't tell	Y
Zawadzka, 1998 (a, c)	can't tell	govt	N	N	can't tell	Y	can't tell	NA	Y	Y

Evidence Table 2: Summary of population characteristics for articles addressing question #1a-c

Study (question)	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Abe, 1987 (a,b)	100	hypertension clinic	hypertensives	anti-hypertensive medication; secondary hypertension	56		52 (8)	96	0
Aylett, 1999 (b)	660	general clinic	hypertensives; anti-hypertensive medication		42			100	100
Uncontrolled hypertensive	258							100	
Untreated hypertensive	236							100	
Helmers, 2000 (c)	194	can't tell	hypertensives	age < 20 and > 65; anti-hypertensive medication; active CHD/CVD	66			100	0
Hoegholm, 1999 (c)	566	general practitioners	hypertensives; normotensives	anti-hypertensive medication; diabetes; active CHD/CVD	47.5			7.4	0
Inden, 1998 (c)	232	hypertension clinic	hypertensives	anti-hypertensive medication	46.9			100	0
Ironson, 1989 (a)	119	can't tell		active CHD/CVD; dizzy spells; asthma	60.5	50.4	34.4 (5.4)		0
Jula, 1999 (a)	233	general clinic	age between 34 and 55; hypertensives	pregnancy; anti-hypertensive medication; diabetes; active CHD/CVD; valvular heart disease	58.4		46 (4.9)	100	0

Study (question)	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Khoury, 1992 (a)	131	general clinic	clinic DBP 90 -115mmHg		52.7	0	53.9	100	
Women	62				0	0	60.2		
Men	69				100	0	50.2		
Age >65	39					0	75.5		
Age <65	92					0	46.3		
MacDonald, 1999 (c)	103	hypertension clinic	age >17; hypertensives; at least 2 BP meds	active CHD/CVD; LVH or target organ damage	53.4		59.4	100	100
Women	48				0		61.1	100	100
Men	55				100		58.4	100	100
Manning, 1999 (c)	186	hypertension clinic	hypertensives	anti-hypertensive medication	51.1		46	100	0
Martinez, 1999 (c)	345	general clinic	age between 18 and 75; hypertensives; Caucasians	normotensives; anti-hypertensive medication; target organ damage; valvular disease	47.8	0	51.8 (10.6)	100	0
Men	165				100	0		100	0
Women	180					0		100	0

Study (question)	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Martinez, 2001 (c)	223	general clinic	hypertensives	age <18 and >75; normotensives; anti-hypertensive medication; diabetes; chronic renal insufficiency; renal transplant active CHD/CVD	49.8		53 (11)	100	0
Mengden, 1991 (a)	127	BP Screening	hypertensives; normotensives	anti-hypertensive medication	62.2		42.7 (11.2)		0
Modesti, 1994 (a)	139	general population	no specific population	hypertensives; anti-hypertensive medication	61.9		38.7 (9.8)	0	
Myers, 1995a (c)	152	hypertension clinic	hypertensives; anti-hypertensive medication	can't tell	42.8				100
Men	65				100		55 (1)		100
Women	87				0		64 (1)		100
Myers, 1995b (a)	147	primary care practice	hypertensives; anti-hypertensive medication	age <21 and > 80; dialysis; chronic renal insufficiency; renal transplant; active CHD/CVD	38.1		64	100	100
Men	56				100				
Women	91				0				
Narkiewicz, 1995 (a)	411	can't tell	borderline /mild hypertension diastolic 90-99;	age <18 and >45; anti-hypertensive medication; BMI>30% of ideal	100		33.7 (8.5)	100	0
Nielsen, 1986 (a)	122	can't tell					47.5		

Study (question)	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Owens, 1999 (c)	1350	hypertension clinic	hypertensives	anti-hypertensive medication	43.4		50.9 (12.4)	100	569
Palatini, 1998 (c)	660	can't tell	age between 18 and 45; white coat hypertensives	anti-hypertensive medication	74.4		33 (9.0)	85.6	0
Pierdomenico, 1995 (c)	255	hypertension clinic	hypertensives	normotensives; anti-hypertensive medication; active CHD/CVD; secondary hypertension; valvular disease; diabetes; renal insufficiency	51.4		49 (14)	100	0
Sega, 1994 (a)	1651	general population	age between 25 and 64						
Staessen, 1999 (a)	808	can't tell	age >60; hypertensives	chronic renal insufficiency;	38.5		69.6 (6.2)		42.6
Stergiou, 1998a (a)	189	hypertension clinic	hypertensives	DBP >120mmHg, SBP >220mmHg; change in medication	56.6			100	41.8
Stergiou, 1998b (b, c)	189	hypertension clinic	hypertensives	DBP>120mmHg, SBP>220mmHg; change in HTN meds	56.6		52.2 (11.5)	100	41.8
Stergiou, 2000 (b, c)	133	hypertension clinic	hypertensives	anti-hypertensive medication; diabetes; dialysis; chronic renal insufficiency; active CHD/CVD; LVH by EKG; clinic BP > 200/115 mmHG	54.9		48.4 (10.2)	70.7	0

Study (question)	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Thijs, 1996 (a)	477	Syst-Eur trial	age>59	active CHD/CVD; secondary hypertension; liver disease, cancer	38.8			100	
Men	292				100				
Women	185				0				
Tochikubo, 1999 (c)	172	can't tell	age between 29 and 76; hypertensives	normotensives; anti-hypertensive medication; active CHD/CVD; anemia; renal disease; valvular disease	51.2				0
Verdecchia, 1992 (c)	260	can't tell	hypertensives	normotensives; anti-hypertensive medication; chronic renal insufficiency; active CHD/CVD	45.4			100	0
Women	142				0		55.4		0
Men	118				100		54.9		0
Verdecchia, 1995 (c)	1414	can't tell		congestive heart failure; valvular disease	44.8		50	87.4	
Verdecchia, 1996 (c)	83	can't tell	white coat hypertensives	hypertensives; medication; CHD/CVD; secondary hypertension; concomitant disease			44.3 (12)	100	0
Weisser, 1994 (a)	503	general population	no specific population	anti-hypertensive medication; serious illness; arm circumference >35cm	52.7		46.5 (12.9)		0

Study (question)	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Men	265				100		46.1		800
Women	238				0		46.9		0
Zachariah, 1988 (a)	168	can't tell	hypertensives	normotensives; anti-hypertensive medication	69.1		51 (9)	79.2	
Zachariah, 1991(a)	126	general clinic	normotensives	hypertensives; active CHD/CVD;	44.4			0	
Zawadzka, 1998 (a, c))	410	can't tell	hypertensives	normotensives; anti-hypertensive medication				100	

Evidence Table 3: Summary of clinic measurement for articles addressing question #1a-c

Study (question)	Device Type	Observer	Position	Measurements (Number)		
				Per Day	Days	Total
Abe, 1987 (a, b)	mercury	physician	sitting	1	3	3
Aylett, 1999 (b)	can't tell	can't tell	can't tell	can't tell		
Helmers, 2000 (c)	can't tell	can't tell	sitting	1	3	3
Hoegholm, 1999 (c)	multiple devices	physician	sitting	3		
Inden, 1998 (c)	mercury	can't tell	sitting	2	3	6
Ironson, 1989 (a)	mercury	can't tell	sitting	2	2	4
Jula, 1999 (a)	mercury	nurse	sitting	2	4	8
Khoury, 1992 (a)	can't tell	nurse	sitting	can't tell		
MacDonald, 1999 (c)	can't tell	nurse	supine	can't tell		
Manning, 1999 (c)	mercury	can't tell	combination	3	3	9
Martinez, 1999 (c)	mercury	nurse, physician	sitting	2	3	6
Martinez, 2001 (c)	mercury	physician	sitting	2	3	6
Mengden, 1991 (a)	aneroid	can't tell	can't tell	1	2	2
Modesti, 1994 (a)	mercury	physician	sitting	1	2	2
Myers, 1995a (c)	mercury	med tech, nurse, physician	combination	2	2	4
Myers, 1995b (a)	mercury	nurse	sitting	3	2	6
Narkiewicz, 1995 (a)	can't tell	can't tell	supine	3	2	6
Nielsen, 1986 (a)	automated	physician	can't tell	3	2	6
Owens, 1999 (c)	can't tell	nurse, physician	sitting	1	2	2
Palatini, 1998 (c)	can't tell	can't tell	supine	3	2	6
Pierdomenico, 1995 (c)	can't tell	can't tell	sitting	3	3	9
Staessen, 1999 (a)	can't tell	can't tell	combination	2	3	6
Stergiou, 1998a (a)	mercury	physician	sitting	2	2	4

Study (question)	Device Type	Observer	Position	Measurements (Number)		
				Per Day	Days	Total
Stergiou, 1998b (b, c)	mercury	physician	sitting	3	2	6
Thijs, 1996 (a)	can't tell	can't tell	sitting	2	3	6
Tochikubo, 1999 (c)	mercury	can't tell	can't tell	3	3	9
Verdecchia, 1995 (c)	can't tell	can't tell	can't tell	can't tell		
Verdecchia, 1996 (c)	mercury	physician	sitting	1	3	3
Weisser, 1994 (a)	automated	physician	sitting	2	2	4
Zachariah, 1988 (a)	mercury	med tech	combination	6	2	12
Zachariah, 1991 (a)	mercury	med tech	combination	6	2	12
Zawadzka, 1991 (a, c))	can't tell	nurse, physician	can't tell	1	3	3

Evidence Table 4: Summary of self measurement for articles addressing question #1a-c

Study	Device			Observer	Time of Recordings[a]			Measurements (Number)		
	Type	Name	Validated		morning	afternoon	evening	Per day	Days	Total
Abe, 1987 (a, b)	electronic or automated	can't tell	unknown	can't tell	Y	Y	Y	2	7	14
Aylett, 1999 (b)	electronic or automated	Omron 705c	Y	patient	can't tell	can't tell	can't tell	can't tell		14
Jula, 1999 (a)	electronic or automated	Omron 705c	Y	patient	Y	N	Y	4	7	28
Mengden, 1991 (a)	aneroid	Sysditon	unknown	patient	Y	N	Y	2	6	12
Nielsen, 1986 (a)	electronic or automated	TM 101	unknown	patient	Y	Y	Y	3	7	21
Sega, 1994 (a)	electronic or automated	HP 5331	unknown	patient	Y	N	Y	1	2	2
Stergiou, 1998a (a)	electronic or automated	Omron 705c	Y	patient	Y	N	Y	4	6	22.8
Stergiou, 1998b (b, c)	electronic or automated	Omron 705c	Y	patient	Y	N	Y	4	6	24
Stergiou, 2000 (b, c)	electronic or automated	Omron 705c	Y	can't tell	Y	N	Y	4	5	20
Weisser, 1994 (a)	electronic or automated	OM 1	unknown	patient	Y	N	Y	2	14	26.7

[a] morning = before noon, afternoon = noon to 6:00pm, evening = after 6:00pm

Evidence Table 5: Summary of ambulatory measurement for articles addressing question #1a-c

Study (question)	Device			Daytime		Nighttime	
	Type	Name	Validated	Definition	Time Interval (mins)	Definition	Time Interval (mins)
Helmers, 2000 (c)	oscillometric	SpaceLabs 90207	Y	7:00am -11:00pm	15	11:00pm - 7:00am	60
Hoegholm, 1999 (c)	oscillometric oscillometric	TM-2420, Model 7 TM-2420, Model 6	Y Y	8:00am - 9:59pm	15	12:00am - 5:59am	30
Inden, 1998 (c)	unknown	Nikon Colin 630	N	7:00am -11:30pm	30	11:00pm - 6:30am	30
Ironson, 1989 (a)	oscillometric	SpaceLabs not specified	unknown	9:00am - 11:00pm	20	can't tell	
Jula, 1999 (a)	auscultatory	Accutracker II	N	6:00pm - 11:00am	15	11:00pm - 6:00am	30
Khoury, 1992 (a)	oscillometric	SpaceLabs 90207	Y	7:00am - 11:00pm	11	11:00pm - 7:00am	60
MacDonald, 1999 (c)	oscillometric	SpaceLabs 90207	Y	8:00am - 10:00pm	20	10:00pm - 8:00pm	60
Manning, 1999 (c)	unknown	Medilog ABP	N	patient reported	30	patient reported	30
Martinez, 1999 (c)	oscillometric	SpaceLabs 90207	Y	10:00am - 8:00pm	15	12:00pm - 6:00am	15
Martinez, 2001 (c)	oscillometric	SpaceLabs 90207	Y	10:00am - 8:00am	15	12:00am - 6:00am	30
Modesti, 1994 (a)	oscillometric	SpaceLabs 90207	Y	7:01am - 10:00pm	15	10:01pm - 7:01am	15
Myers, 1995a (c)	oscillometric oscillometric unknown	SpaceLabs 90202 SpaceLabs 90207 SpaceLabs 5200	Y Y unknown	can't tell	can't tell	can't tell	can't tell
Myers, 1995b (a)	oscillometric oscillometric	SpaceLabs 90202 SpaceLabs 90207	Y Y	can't tell	15	not measured	
Narkiewicz, 1995 (a)	oscillometric oscillometric	SpaceLabs 90207 TM-2420, Model 7	Y Y	6:00am - 11:00pm	10	11:00pm - 6:00am	30
Owens, 1999 (c)	oscillometric	SpaceLabs 90207	Y	9:00am - 9:00pm	30	9:01pm - 12:59am	30
Palatini, 1998 (c)	oscillometric auscultatory	SpaceLabs 90207 TM 2420, Model 7	Y Y	6:00am - 11:00pm	10	11:00pm - 6:00am	30
Pierdomenico, 1995 (c)	oscillometric oscillometric	SpaceLabs 90202 SpaceLabs 90207	Y Y	6:00am - 12:00pm	15	12:00pm - 6:00am	30
Sega, 1994 (a)	oscillometric	SpaceLabs 90207	Y	7:00am - 11:00pm	20	11:00pm - 7:00am	20

Study (question)	Device			Daytime		Nighttime	
	Type	Name	Validated	Definition	Time Interval (mins)	Definition	Time Interval (mins)
Staessen, 1999 (a)	oscillometric oscillometric	SpaceLabs 90202 SpaceLabs 90207	Y	10:00am - 8:00pm	30	12:00am - 6:00am	30
Stergiou, 1998a (a)	oscillometric	SpaceLabs 90207	Y	patient reported	20	patient reported	20
Stergiou, 1998b (b, c)	oscillometric	SpaceLabs 90207	Y	patient reported	20	patient reported	20
Stergiou, 2000 (b, c)	oscillometric	SpaceLabs 90207	Y	can't tell	20	can't tell	20
Thijs, 1996 (a)	oscillometric oscillometric unknown	SpaceLabs 90202 SpaceLabs 90207 Plus other unspecified	Y Y unknown	10:00am - 8:00pm	30	12:00am - 6:00am	30
Tochikubo, 1999 (c)	unknown	TM-2425	unknown	patient reported	30	patient reported	30
Verdecchia, 1992 (c)	oscillometric oscillometric unknown	SpaceLabs 90202 SpaceLabs 90207 SpaceLabs 5200	Y Y unknown	6:00am - 10:00pm	15		15
Verdecchia, 1995 (c)	oscillometric oscillometric unknown	SpaceLabs 90202 SpaceLabs 90207 SpaceLabs 5200	Y Y unknown	6:00am - 10:00pm	15	10:00pm - 6:00am	15
Verdecchia, 1996 (c)	oscillometric oscillometric	SpaceLabs 90202 SpaceLabs 90207	Y Y	6:00am - 10:00pm	15	10:00pm - 6:00am	15
Zachariah, 1988 (a)	unknown	Pressurometer III	unknown	can't tell	7.5	can't tell	15
Zachariah, 1991 (a)	unknown	Pressurometer	unknown	can't tell	7.5	can't tell	15
Zawadzka, 1998 (a, c)	auscultatory	TM 2420	unknown	can't tell	30	not measured	

Evidence Table 6: Distribution of readings between clinic and self-measured blood pressure (question #1a)

Study	N	Mean (SD) Systolic BP		Systolic Difference		Mean (SD) Diastolic BP		Diastolic Difference	
		Clinic	SMBP	Mean (SD)	P-value	Clinic	SMBP	Mean (SD)	P-value
Abe, 1987	100	165.5 (20.6)	147.8 (15.9)	17.7	<0.001	101.2 (10.1)	94.9 (10.8)	6.3	<0.001
Jula, 1999	233	144.5 (12.6)	138.9 (13.1)	5.6 (8.8)	<0.001	94.5 (7.4)	92.9 (8.6)	1.7 (6.5)	<0.001
Mengden, 1991	127	131.3 (18.9)	125.9 (15.5)	5.4	<0.01	85.6 (13.3)	84.1 (11)	1.5	<0.01
Nielsen, 1986	122			13	>0.05			5	>0.05
Stergiou, 1998b	189	142.9 (16.3)	137.5 (16.2)	5.4	<0.001	91.2 (9.9)	85.9 (9.9)	5.3	<0.001
Weisser, 1994	503	130 (16.5)	123.1 (14.6)	6.9	<0.01	82.1 (11.1)	77.6 (10.7)	4.5	<0.01
Women	238	126.4 (17.2)	118.9 (16.1)	7.5	<0.01	79.3 (11.2)	74.4 (11.1)	4.9	<0.01
Men	265	133.4 (15.1)	126.9 (12)	6.5	<0.01	84.7 (10.3)	80.5 (9.7)	4.2	<0.01

Evidence Table 7: Distribution of readings between clinic blood pressure and ambulatory blood pressure measurement, systolic (question #1a)

Study	N	Mean (SD) mmHG				Difference (SD) from clinic					
		Clinic	Daytime	Nighttime	24hr	Daytime	P-value	Nighttime	P-value	24hr	P-value
Ironson, 1989	119	126 (17.2)	121 (18.4)			5	<0.001				
Jula, 1999	233	144.5 (12.6)	148.3 (13.9)	125.5 (16.4)	141.7 (14)	-3.8 (9.9)	<0.001	19		2.8	
Khoury, 1992	131	155.4			138.4					17	<0.001
Women	62	160			137.8					22.2	<0.05[a]
Men	69	151.2			138.8					12.4	<0.05[a]
Age <65	92	150.9			135.3					15.6	<0.05[a]
Age >65	39	164.8			145					19.8	<0.05[a]
Modesti, 1994	139	129 (16)	120 (11)	107 (12)	117 (11)	9	<0.001	22	<0.001	12	<0.001
Myers, 1995b	147	137	132			14	<0.001				
Narkiewicz, 1995	411	146.1 (10.4)	134.9 (11)	117.7 (11.4)		11.2 (12.9)					
Staessen, 1999	808	173.3 (10.8)	151.4 (16.2)	134 (18.6)	145.8 (15.6)	21.9	<0.001				
Stergiou, 1998b	189	142.9 (16.3)	136 (14.3)	119 (13.3)	129.8 (13.2)	6.9	<0.001	23.9	<0.001	13.1	<0.001
Thijs, 1996	477	174 (12)	153	136	148	21	<0.001				
Women	292	175	153 (17)	134 (19)	147 (16)	22 (8)	<0.05[a]				
Men	185	174	154 (16)	139 (18)	149 (15)	19 (8)	<0.05[a]				
Zachariah, 1991	126	118 (13)			125					-7(7)	<0.001
Zachariah, 1988	168	149 (14)	145 (16)		141 (16)	4	<0.001			8	<0.001
Zawadzka, 1998	410	168.4 (21.8)				11.5 (13.4)					

[a] P-value determine by standard error or standard deviation of two groups

Evidence Table 8: Distribution of readings between clinic and ambulatory blood pressure, diastolic (question #1a)

Study	N	Mean (SD) mmHg				Difference (SD) from clinic					
		Clinic	Daytime	Nighttime	24hr	Daytime	P-value	Nighttime	P-value	24hr	P-value
Ironson, 1989	119	83 (12.4)	80 (14.4)			3	<0.001				
Jula, 1999	233	94.5 (7.4)	91.9 (7.8)	75.6 (8.9)	87.2 (7.6)	2.7 (6.8)	<0.001	18.9		7.3	
Khoury, 1992	131	93.1			85.4					7.7	<0.0001
Women	62	92.9			83.2						<0.05[a]
Men	69	93.2			87.3						<0.05[a]
Age <65	92	94			85.4						<0.05[a]
Age >65	39	90.8			85.4					5.4	<0.05[a]
Modesti, 1994	139	85 (11)	75 (8)	63 (11)	71 (8)	10	<0.001	22	<0.001	14	<0.001
Myers, 1995b	147	78	78								
Narkiewicz, 1995	411	95.6 (3.7)	83.8 (8.2)	73.4 (8.3)		11.8 (8.1)					
Staessen, 1999	808	86 (5.8)	84.1 (9.8)	70.2 (10.1)	79.3 (8.9)	1.9	<0.001				
Stergiou, 1998b	189	91.2 (9.9)	86.8 (11.1)	71.4 (10.1)	71.4 (10.1)	4.4	<0.001	19.8	<0.001	10.2	<0.001
Thijs, 1996	477	86 (6)	85	71	80	1	> 0.05				
Women	292	86	84 (10)	69 (11)	79 (10)						
Men	185	86	86 (9)	73 (10)	81 (8)						
Zachariah, 1988	168	99 (6)	96 (7)		93 (7)	3	<0.001			6	<0.001
Zachariah, 1991	126	75 (7)			72					3 (6)	<0.0001
Zawadzka, 1998	410	106.8 (10.1)				5.8 (8.5)					

[a] P-value determined by standard error or standard deviation of groups

Evidence Table 9: Distribution of readings between self-measured blood pressure and ambulatory blood pressure measurement, systolic (question #1a)

Study	N	Mean (SD) mmHg				Difference (SD) from self					
		Self	Daytime	Nighttime	24hr	Daytime	P-value	Nighttime	P-value	24hr	P-value
Sega, 1994	1651	119			118					1	<0.01
Stergiou, 1998b	189	137.5 (16.2)	136 (14.3)	119 (13.3)	129.8 (13.2)	1.5	>0.05	18.5	<0.001	7.7	<0.001
Stergiou, 2000	133	138.7 (15.6)	139.3 (12.8)			-0.6 (11.8)	>0.05				

Evidence Table 10: Distribution between self-measured blood pressure and ambulatory blood pressure measurement, diastolic (question #1a)

Study	N	Mean (SD) mmHg				Difference (SD) from self					
		Self	Daytime	Nighttime	24hr	Daytime	P-value	Nighttime	P-value	24hr	P-value
Sega, 1994	1651	75			74					1	<0.01
Stergiou, 1998a	189	85.9 (9.9)	86.8 (11.1)	71.4 (10.1)	81.0 (10.4)	-0.9 (7)	>0.05	14.5	<0.001	4.9	<0.001
Stergiou, 2000	133	89.3 (8.6)	91.1 (9.9)			-1.8 (6.7)	>0.05				

Evidence Table 11: Prevalence of white coat hypertension by self-measured blood pressure (question #1b)

Study	N	Definition of Hypertension		Prevalence WCH (%)
		Clinic	SMBP	
Abe, 1987	100	Hypertension was defined by 1962 WHO classification	Hypertension was defined by 1962 WHO classification	17
Aylett, 1999	660	All participants with clinic hypertension (defined as SBP ≥ 160 and DBP ≥ 100 mmHg)	WCH present if mean SMBP < 150 / 85 mmHg	16.5
Uncontrolled hypertensive	424			17
Untreated hypertensive	236			27
Stergiou, 1998a	189		WCH present if difference between clinic and mean self SBP > 20 mmHg or self DBP> 10 mmHg	25.9
Stergiou, 2000	133	All participants with clinic hypertension defined by A) SBP ≥ 140 and DBP ≥ 90 mmHg B) SBP/DBP ≥135/85 mmHg	A) WCH present if mean self BP ≤ 140 / 90 mmHg B) WCH present if mean self BP ≤ 135 / 85 mmHg	A) 33 B) 13

Evidence Table 12: Prevalence of white coat hypertension by ambulatory blood pressure (question #1c)

Study	N	Definition of Hypertension		Prevalence WCH (%)
		Clinic	ABP	
Helmers, 2000	194	All participants with clinic hypertension (defined as DBP ≥ 90 and ≤ 105 mmHg)	WCH present if mean **daytime** ambulatory DBP ≤ 85 mmHg	21.6
Men	128			14.84
Women	66			34.84
Hoeglholm, 1999	269	All participants with clinic hypertension (defined as DBP ≥ 90 mmHg)	WCH present if mean **daytime** ambulatory BP < 135 / 90 mmHg	18.1
Men	269			11.6
Women	297			23.8
Inden, 1998	232	All participants with clinic hypertension (defined as SBP ≥ 140 or DBP ≥ 90 mmHg)	A) WCH present if mean **24-hour** ambulatory SBP <135 mmHg and DBP < 85 mmHg B) WCH present if mean **daytime** ambulatory SBP< 120 mmHg and DBP < 75 mmHg	A) 13 B)19

Study	N	Definition of Hypertension		Prevalence WCH (%)
		Clinic	ABP	
MacDonald, 1999	103	All participants with clinic hypertension (defined as SBP > 140 to <200 mmHg or DBP > 90 to <120 mmHg)	WCH present if mean **daytime** ambulatory SBP< 140 mmHg and DBP < 90 mmHg or "if the systolic/diastolic pressure was at least 20/15 mmHg. (Both) lower than the clinic reading".	36
Men	55			20
Women	48			54
Manning, 1999.	186	All participants with clinic hypertension (defined as SBP ≥ 140/ 90 mmHg)	WCH present if mean **daytime** ambulatory SBP ≤ 136/86 mmHg	23
Men	95			10.2
Women	91			12.4
Martinez, 1998	345	All participants with clinic hypertension (defined as SBP > 140 and < 179 mmHg or DBP > 90 and 109 mmHg)	A) WCH present if mean **daytime (10 am - 8 pm)** ambulatory SBP < 135 mmHg and DBP < 85 mmHg B) WCH present if mean **daytime (9am - 10 pm)** ambulatory SBP <131 / 86 mmHg (women) and < 136/87 mmHg (men)	A) 39 B) 35
Men	165			A) 31
Women	180			A) 47

Study	N	Definition of Hypertension		Prevalence WCH (%)
		Clinic	ABP	
Martinez, 2001	223	All participants with clinic hypertension (defined as SBP > 140 to < 159 or DBP > 90 to < 99 mmHg)	Men: WCH present if mean daytime ambulatory SBP < 135 mmHg and DBP < 86 mmHg Women: WCH present if mean daytime ambulatory SBP <130 mmHg and DBP < 85 mmHg	32.3
Myers, 1995a	152		A) WCH present if difference between clinic and mean **daytime** ambulatory SBP > 20 mmHg or ambulatory DBP > 10 mmHg) B) Severe WCH present if difference between clinic mean **daytime** ambulatory SBP > 40 mmHg or DBP > 20 mmHg)	A) 67.1 B)32.2
Men	65		A. WCH B. Severe WCH	A) 55.4 B) 12.3
Women	87		A. WCH B. Severe WCH	A) 80.5 B) 47.1
Owens, 1999	1350	All participants with clinic hypertension (defined as SBP ≥ 140 mmHg and DBP ≥ 90 mmHg)	WCH present if mean **daytime** ambulatory BP ≤ 135 / 85 mmHg	11

Study	N	Definition of Hypertension		Prevalence WCH (%)
		Clinic	ABP	
Pierdomenico, 1995	255	All participants with clinic hypertension (defined as SBP > 140 or DBP> 90 mmHg)	WCH considered present if: A) **24-hour** ambulatory SBP< 135 mmHg and DBP< 85 mmHg B) **Daytime** ambulatory SBP< 134 mmHg and DBP< 90 mmHg C) **Daytime** ambulatory SBP<136 mmHg and DBP< 90 mmHg D) **Daytime** ambulatory SBP < 146 mmHg and DBP < 91 mmHg	A) 21 B) 18.4 C) 19.2 D) 22.7
Stergiou, 1998a	189		WCH present if difference between clinic and mean **daytime** ambulatory SBP > 20 mmHg or ambulatory DBP> 10 mmHg)	25.9

Study	N	Definition of Hypertension		Prevalence WCH (%)
		Clinic	ABP	
Stergiou, 2000	133	All participants with clinic hypertension defined as: A) SBP ≥ 140 mmHg or DBP ≥ 90 mmHg B) BP ≥ 135/85 mmHg	A) WCH present if mean **daytime** ambulatory BP ≤ 140 / 90 mmHg B) WCH present if mean **daytime** ambulatory BP ≤ 135 / 85 mmHg	A) 24 B) 11
Tochikubo, 1998	172	All participants with clinic hypertension (defined as SBP > 140 mm Hg or DBP > 90 mm Hg)	WCH present if mean **24- hour** ambulatory SBP< 133 mmHg and DBP < 82 mmHg	22
Verdecchia, 1992	260	All participants with clinic hypertension (defined as DBP > 90 or SBP> 160 mmHg)	WCH considered present if the mean **daytime** ambulatory SBP < 134 mmHg and DBP <88 mmHg	11.9
Men	118			11
Women	142			12.7
Verdecchia, 1995	1414	All participants with clinic hypertension (defined as SBP ≥ 140 or DBP ≥ 90 mmHg)	Men: WCH present if mean **daytime** ambulatory SBP< 136 mmHg and DBP < 87 mmHg Women: WCH present if mean **daytime** ambulatory SBP<131 mmHg and DBP < 86 mmHg	18.9

Study	N	Definition of Hypertension		Prevalence WCH (%)
		Clinic	ABP	
Zawadzka, 1998	410	All participants with clinic hypertension (defined as DBP ≥90 mmHg)	WCH present if mean **daytime** ambulatory DBP ≤ 90 mmHg	30.2

Evidence Table 13: Reproducibility of white coat hypertension (WCH) (question #1c)

Study	N	Interval between Assessments	Definition of Hypertension		Prevalence of WCH[a]	
			Clinic	Ambulatory	Initial N (%)	Repeat N (%)
Palatini, 1998	565	3 months	Clinic SBP 140-159 mmHg and/or DBP 90-99mmHg	WCH present if ABP: < 130/80mmHg	90 (100)	38 (42)
Verdecchia, 1996	83	2.5 years	Clinic SBP $\geq$ 140 and/or DBP $\geq$ 90 mmHg	WHC present if ABP: women < 131/86 mmHg men: < 136/87 mmHg	83 (100)	52 (63)

[a] WCH defined by hypertension by clinic BP, non-hypertension by ambulatory BP

Evidence Table 14: Summary of quality characteristics for articles addressing question #2

Study	Centers	Funding	Adequate Description		Clinic BP Observer			Self BP Instructions Provided	Ambulatory BP Trained	Statistical Variability Reported
			Eligibility	Baseline Characteristics	Trained	Blinded	Standard Technique			
Jula, 1999	single	can't tell	Y	Y	Y	Y	Y	Y	can't tell	Y

Evidence Table 15: Summary of population characteristics for articles addressing question #2

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Jula, 1999	233	general clinic	age between 34 and 55; hypertensives	pregnancy; anti-hypertensive medication; diabetes; active CHD/CVD; valvular heart disease	58.4		46 (4.9)	100	0

Evidence Table 16: Summary of clinic measurements for articles addressing question #2

Study	Device Type	Observer	Position	Measurements (number)		
				Per Day	Days	Total
Jula, 1999	mercury	nurse	sitting	2	4	8

Evidence Table 17: Summary of self measurement for articles addressing question #2

Study	Device			Observer	Time of Recordings[a]			Measurements (Number)		
	Type	Name	Validated		Morning	Afternoon	Evening	Per day	Days	Total
Jula, 1999	electronic or automated	Omron 705c	Y	patient	Y	N	Y	4	7	28

[a] morning = before noon, afternoon = noon to 6:00pm, evening=after 6:00pm

Evidence Table 18: Characteristics of measures of left ventricular mass (question #2)

Study	Left ventricular mass		Left ventricular hypertrophy	
	Units	Mean (SD)	Criteria	Prevalence (%)
Jula, 1999	LV mass by surface area (g/m^2)	111 (2.5)	unknown	unknown

Evidence Table 19: Correlation of clinic and self-measured blood pressure with left ventricular mass (question #2)

Study	Systolic BP		Diastolic BP		Adjustment factors
	Clinic	Self	Clinic	Self	
Jula, 1999	0.4 (<0.001)	0.47 (<0.001)	0.37 (<0.001)	0.44 (<0.001)	unadjusted

Evidence Table 20: Characteristics of albuminuria measurement (question #2)

Study	Measurement	Collection Period	Mean (SD)	Criteria	Prevalence (%)
Jula, 1999	mg/24hrs	24 hours	25.7 (39.3)	NA	NA

Evidence Table 21: Correlation of clinic and self-measured blood pressure with albuminuria (question #2)

Study	Systolic BP		Diastolic BP		Adjustment factors
	Clinic (P-value)	Self (P-value)	Clinic (P-value)	Self (P-value)	
Jula, 1999	0.34 (<0.001)	0.32 (<0.001)	0.25 (<0.001)	0.28 (<0.001)	unadjusted

Evidence Table 22: Summary of quality characteristics for prospective studies addressing question #2 (question #2b)

Study	Centers	Funding	Adequate description		Clinic BP Observer			Self BP Instructions Provided	Blinded Outcome Assessment	Followup data for ≥80%	Statistical Variability Reported
			Eligibility	Baseline Characteristics	Trained	Blinded	Standard Technique				
Ohkubo, 1998	single	govt, other	Y	Y	can't tell	N	Y	Y	N	Y	Y
Sakuma, 1997	single	govt, other	Y	N	can't tell	N	can't tell	Y	N	Y	Y

Evidence Table 23: Summary of population characteristics for prospective studies addressing question #2 (question #2b)

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Ohkubo, 1998	1728	general population in Japan	age ≥40	demented; bedridden; hospitalized	41.7		61		33.7
Sakuma, 1997	1256	general population in Japan	age≥40	demented; bedridden; hospitalized; prior stroke, atrial fibrillation	40.4		59.1 (11)		

Evidence Table 24: Summary of clinic measurement characteristics for prospective studies (question #2b)

Study	Device Type	Observer	Position	Measurements (Number)		
				Per Day	Days	Total
Ohkubo, 1998	automated	med tech, nurse	sitting	2	1	2
Sakuma, 1997	automated	nurse, physician	sitting	2	1	2

Evidence Table 25: Summary of self measurement characteristics for prospective studies addressing question #2 (question #2b)

Study	Device			Observer	Time of Recordings[a]			Measurements (Number)		
	Type	Name	Validated		Morning	Afternoon	Evening	Per day	Days	Total
Ohkubo, 1998	electronic or automated	HEM 401C	unknown	patient	Y	N	N	1	28	20.8
Sakuma, 1997	electronic or automated	HEM 401C	unknown	patient	Y	N	N	1	28	23

[a] morning = before noon, afternoon = noon to 6:00pm, evening = after 6:00pm

Evidence Table 26: Summary of methods in prospective studies (question #2b)

Study	Duration of follow-up Years	N	Outcome of Interest			Analyses Adjusted for	Comparison of Prediction
			n	Outcome	Description		
Ohkubo[a], 1998	6.6 (2.3)	1728	52	CVD Mortality	Deaths from cerebrovascular disease and cardiovascular disease	Age, Gender, Smoking, Prior CVD, BP medication	Not tested
		1728	160	Total Mortality	Total mortality		
Sakuma[a], 1997	4.4 (2.1)	1256	39	Stroke	Cerebral hemorrhage, Cerebral infarction, Subarachnoid hemorrhage or Undetermined type of stroke	Age, Gender, Smoking, BP level	Not tested

[a] Both papers from Ohasama study

Evidence Table 27: Prediction of outcome by clinic blood pressure and self-measured blood pressure (question #2b)

Study	Outcome	Contrast	Clinic Systolic		Self Systolic		Clinic Diastolic		Self Diastolic	
			Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value
Ohkubo, 1998	CVD Mortality	Per mmHg	1	0.97	1.021	0.048	1.005	0.704	1.013	0.414
	Total Mortality	Per mmHg	1.001	0.84	1.014	0.012	1.002	0.73	1.012	0.16
Sakuma, 1997	Stroke	2nd VS 1st Quintile	2.12[b]	NS	1.03[b]	NS	2.89	NS	0.88[b]	NS
		3rd VS 1st Quintile	1.33[b]	NS	0.18[b]	NS	2.79	NS	1.06[b]	NS
		4th VS 1st Quintile	0.6[b]	NS	1.46[b]	NS	2.7	NS	1.19[b]	NS
		5th VS 1st Quintile	3.6[b]	<0.05	2.56[b]	NS	6.12	<0.05	3.12[b]	<0.05

[a] Both papers from Ohasama study
[b] Calculated from data in paper

Evidence Table 28: Summary of quality characteristics for self-measured blood pressure trials (question #2d)

Study	Center	Funding	Adequate Description					Self BP Instruction Provided	Outcome Assessor Blinded[a]	Between Group P-value Reported
			Eligibility	Sample Size Justification	Randomization	BP Therapy	Outcomes			
Bailey, 1999	single	can't tell	N	N	N	Y	Y	Y	N	Y
Binstock, 1988	single	can't tell	N	N	N	N	N	N	N	Y
Carnahan, 1975	single	can't tell	N	N	N	Y	Y	Y	Y	Y
Earp, 1982	single	govt	Y	N	N	N	Y	Y	Y	Y
Friedman, 1996	single	govt	Y	N	Partial	N	Y	N	Y	Y
Johnson, 1978	single	govt	Partial	N	Y	N	N	Y	Y	Y
Lehnert, 1987	can't tell	can't tell	Y	N	Y	Y	Y	Y	N	N
Midanik, 1991	single	other	N	N	N	N	Y	Y	N	N
Rogers, 2001	single	industry	Y	Y	Y	N	Y	Y	Y	Y
Soghikian, 1992	can't tell	other	N	N	Partial	N	Y	Y	N	N
Stahl, 1984	single	govt	Y	N	Y	Y	N	Y	N	N

Study	Center	Funding	Adequate Description					Self BP Instruction Provided	Outcome Assessor Blinded[a]	Between Group P-value Reported
			Eligibility	Sample Size Justification	Randomization	BP Therapy	Outcomes			
Vetter, 2000	multi	industry	Y	N	Partial	Y	Y	Y	N	N

Evidence Table 29: Summary of population characteristics for self-measured blood pressure trials (question #2d)

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Bailey, 1999	62	general clinic	inadequately controlled hypertension	unable to record self-BP	53.2		55.0	100	93.5
Binstock, 1988	112	can't tell	hypertensives	can't tell	40			100	
Carnahan, 1975	100	hypertension clinic	hypertensives	can't tell	98		55.2	100	0
Earp, 1992	218	general clinic, hypertension clinic	hypertensives; anti-hypertensive medicaton	alcoholism; mental illness	41	77	47.4	100	100
Friedman, 1996	267	general population	age >60 ; hypertensives; anti-hypertensive medication	unable to record self-BP	22.8	10.5	76.5		
Johnson, 1978	140	general population	age between 34 and 66; hypertensives; anti-hypertensive medication; uncontrolled BP on medication	can't tell	58.6		53.0	100	100
Lehnert, 1987	189	rehabilitation center	age between 19 and 61; hypertensives	diabetes; active CHD/CVD; secondary hypertension	78.3		41.2	100	63.5
Midanik, 1991	204	general clinic	untreated hypertensives	can't tell	47.5	48.5	47.3	100	0
Rogers, 2001	121	general clinic	hypertensives with elevated BP or symptoms	age <18; pregnancy; secondary hypertension	49.6	9.1	61.4	100	
Soghikian, 1992	430	general clinic	hypertensives	active CHD/CVD	49.8	39.1	54.3	100	85.1
Stahl, 1984	396	screening events	age between 15 and 71; hypertensives	anti-hypertensive medication	57.9	76.2	47.5	100	

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Vetter, 2000	622	general clinic	age between 17 and 86; hypertensives; anti-hypertensive medication	proteinuria/albuminuria; active CHD/CVD; contraindication to losartan; hepatic disease	49.2		57.5		100

Evidence Table 30: Summary of methods for self-measured blood pressure trials (question #2d)

Study	Objective	Duration (months)	Group	N	SMBP Intervention			
					Device Type	Device Name	SMBP Frequency	Co-Intervention
Bailey, 1999	To determine the effects of SMBP on BP control.	2	Control	30				
			SMBP	32	electronic or automated	Omron HEM 706	twice daily	
Binstock, 1988	To compare the effects of different compliance techniques with education alone (control group) on BP.	12	Control	32				
			SMBP	23	can't tell	can't tell	not discussed	
			Compliance Contract	15				
			Calender pill count	30				
			All of the above	11	can't tell	can't tell	not discussed	
Carnahan, 1975	To determine the effects of SMBP on BP control.	6	Control		electronic or automated	Ultrasphyg Lumiscope		
			SMBP				twice daily	
Earp, 1982	To determine the effects of social support strategies on BP control.	24	Control	63				
			SMBP and social support	99	can't tell	can't tell	not discussed	activated significant other
			Home visits	56				

Study	Objective	Duration (months)	Group	N	SMBP Intervention			
					Device Type	Device Name	SMBP Frequency	Co-Intervention
Friedman, 1996	To determine the effects of a SMBP / telecommunication system (TLC) on BP control.	6	Control	134				
			TLC	133	electronic or automated	Omron	weekly	telephone evaluation of medications, adherence, and symptoms
Johnson, 1978	To determine if SMBP improves BP control and compliance in poorly controlled hypertensives.	6	Control	34				
			SMBP and Home visit	35	can't tell	Taylor Syborn Corporation, Arden, NC	not discussed	
			SMBP	34			not discussed	
			Home visit	33				
Lehnert, 1987	To determine the effects of a multi-dimensional behavioral training program on BP.	1.5	Control	81				low salt diet, physical training
			Program	108	mercury		three times daily	low salt diet, physical training, multidimensional behavioral program

Study	Objective	Duration (months)	Group	N	SMBP Intervention			
					Device Type	Device Name	SMBP Frequency	Co-Intervention
Midanik, 1991	To determine the effects of SMBP on BP control.	12	Control	102				
			SMBP	102	electronic or automated	Tyco self check digital device	twice weekly	monthly BP reports sent to participants
Rogers, 2001	To determine if SMBP with telemetric transmission of data reduces BP.	2	Control	61				
			SMBP	60	electronic or automated	52500, Welch Allyn Inc.	3 each morning and evening, 3 days per week	weekly reports provided to patients and physicians
Soghikian, 1992	To determine the effects of SMBP on BP control.	12	Control	215				
			SMBP	215	electronic or automated	Tyco self check model 7052-8	twice weekly	monthly BP reports sent to MD and participant
Stahl, 1984	To determine whether BP monitoring by self (SMBP) or family reduces BP.	6	Control	173				
			Family monitoring of BP	79			not discussed	
			SMBP	144	mercury		not discussed	

Study	Objective	Duration (months)	Group	N	SMBP Intervention			
					Device Type	Device Name	SMBP Frequency	Co-Intervention
Vetter, 2000	To determine the effects of SMBP on BP control.	2	Control	326				
			SMBP	296	electronic or automated	Omron HEM 605	twice daily in morning	

Evidence Table 31: Characteristics of outcome measurements in self-measured blood pressure trials (question #2d)

Study	Measure	Device	Position	Measurements (Number)		
				Per Day	Days	Total
Bailey, 1999	clinic	mercury	sitting	can't tell		
Binstock, 1988	clinic	can't tell	can't tell	can't tell		
Carnahan, 1975	clinic	can't tell	sitting	3	1	3
Earp, 1982	clinic	can't tell	can't tell	can't tell		
Friedman, 1996	clinic	can't tell	can't tell	2	1	2
Johnson, 1978	clinic	can't tell	can't tell	can't tell		
Lehnert, 1987	clinic	can't tell	can't tell	1	3	3
Midanik, 1991	clinic	can't tell	can't tell	2	1	2
Rogers, 2001	ambulatory	SpaceLabs 90207	NA	NA	1	
Soghikian, 1992	clinic	can't tell	can't tell	1	1	1
Stahl, 1984	clinic	can't tell	can't tell	can't tell		
Vetter, 2000	clinic	can't tell	sitting	3	1	3

Evidence Table 32: Results of self-measured blood pressure trials (question #2d)

Study	Group	Systolic BP (mmHg)			Diastolic BP (mmHg)			Other Findings and Comments
		Baseline Mean (SD)	Change from Baseline in intervention groups, net of control		Baseline Mean (SD)	Change from Baseline in intervention groups, net of control		
			Change	P-value		Change	P-value	
Biley, 1999	Control	155 (21.52)			95 (10.76)			BP medications were more likely to be unchanged or increased in control group
	SMBP	156 (22.24)	5	<0.05	93 (11.12)	2	NS	
Binstock, 1988	Control	151			89			Unclear if significance test pertains to pair wise contrasts or overall comparison to control
	SMBP	149	-10	<0.01	90	-5	<0.01	
	Compliance Contract	142	-11	<0.01	88	-6	<0.01	
	Calender pill count	156	-17	<0.01	92	-10	<0.01	
	All of above	147	-10	<0.01	88	-7	<0.01	
Camhan, 1975	Control	156.6			103.6			
	SMBP	152.7	-7.5	<0.05	101.7	0	NS	
Earp, 1982	Control							BP control (DBP <95mmHg) significantly improved in both intervention groups (75% and 79%) compared to control group (58%) at end of follow-up.
	SMBP and social support							

Study	Group	Systolic BP (mmHg)			Diastolic BP (mmHg)			Other Findings and Comments
		Baseline Mean (SD)	Change from Baseline in intervention groups, net of control		Baseline Mean (SD)	Change from Baseline in intervention groups, net of control		
			Change	P-value		Change	P-value	
	Home visits							
Friedman, 1996	Control				84			Improved adherence in TLC group
	TLC		-4.7	0.2	86.1	-4.4	0.02	
Johnson, 1978	Control				103.2 (10.2)			
	SMBP and Home visit				104.2 (6.5)	-0.5	NS	
	SMBP				102.6 (7.2)	-1.3	NS	
	Home visit				103.9 (6.31)	-0.9	NS	
Lehnert, 1987	Control	169.8			104			Fewer persons on medications and less medication use in active treatment group
	Program	168.4	-0.4		104.6	0.5		
Midanik, 1991	Control	144 (16.8)			92.7 (7.7)			No difference in percent of participants started on medications
	SMBP	144.4 (15.7)	-2.4	NS	91.3 (9.1)	0.1	NS	

Study	Group	Systolic BP (mmHg)			Diastolic BP (mmHg)			Other Findings and Comments
		Baseline Mean (SD)	Change from Baseline in intervention groups, net of control		Baseline Mean (SD)	Change from Baseline in intervention groups, net of control		
			Change	P-value		Change	P-value	
Rogers, 2001	Control							Similar results by gender. Significant net reduction in mean arterial pressure in African Americans (14.9 mmHg)
	SMBP		-4.8[a]	0.047		-4.1[a]	0.01	
Soghikian, 1992	Control	140.2 (17.91)			86.3 (11.02)			Reduced HTN costs and visits in SMBP group. Significant BP reduction in men but not in women
	SMBP	137.4 (16.96)	-4.5	<0.05	86.1 (8.48)	-1.6	0.05	
Stahl, 1984	Control				108.6			Fewer dropouts from family care group
	Family monitoring of BP				107	-0.9	NS	
	SMBP				109.7	-1.1	NS	
Vetter, 2000	Control	168.1 (14.44)			102 (5.95)			BP control (diastolic BP $\leq$ 90 mmHg) 66.2% in SMBP vs 59.8% in control ($0.05<p<0.10$), achieving statistical significance in women (73.2% vs 64.1%, $p<0.01$) but not in men (59.2% vs 55.3%, $p>0.20$).
	SMBP	166.1(14.44)	-0.05		101.9 (6.19)	-1.3		

[a] Ambulatory Blood Pressure

Evidence Table 33: Summary of quality characteristics for articles addressing question #3

Study	Center	Funding	Adequate Description		Clinic BP Observer			Ambulatory BP Trained	Statistical Variability Reported
			Eligibility	Baseline Characteristics	Trained	Blinded	Standard Technique		
Baguet, 2001	single	can't tell	Y	Y	can't tell	Y	Y	Y	Y
Bauduceau, 1998	multi	can't tell	Y	Y	can't tell	Y	N	can't tell	Y
Chen, 1995	multi	govt, other	Y	Y	can't tell	N	can't tell	Y	Y
Cuspidi, 2000	single	can't tell	Y	Y	can't tell	N	Y	Y	Y
Devereux, 1983	single	govt, other	Y	Y	can't tell	N	can't tell	Y	Y
Ferrara, 1997	single	can't tell	Y	Y	can't tell	Y	Y	Y	Y
Gosse, 1993	single	can't tell	Y	Y	can't tell	N	can't tell	can't tell	Y
Gosse, 1997	single	can't tell	Y	Y	can't tell	Y	N	N	Y
Hansen, 1992	single	other	N	Y	can't tell	N	N	Y	Y
Hoegholm, 1994	multi	other	Y	Y	can't tell	Y	can't tell	can't tell	Y
Hoegholm, 1999	multi	can't tell	Y	Y	N	Y	N	can't tell	Y
Jula, 1999	single	can't tell	Y	Y	Y	Y	Y	can't tell	Y
Lemne, 1995	single	govt, industry	Y	Y	Y	Y	Y	can't tell	Y
Manning, 1999	single	can't tell	Y	Y	can't tell	Y	Y	Y	Y
Martinez, 1999	multi	govt, industry	Y	Y	Y	Y	Y	Y	Y
Martinez, 2001	multi	govt, industry	Y	Y	can't tell	Y	Y	Y	Y
Myers, 1995b	single	can't tell	Y	Y	Y	Y	can't tell	can't tell	Y
Palatini, 1998	multi	can't tell	Y	Y	can't tell	N	Y	Y	Y
Pierdomenico, 1995	single	can't tell	Y	Y	can't tell	Y	Y	Y	Y
Pose-Reino, 1996	single	can't tell	Y	Y	can't tell	Y	can't tell	can't tell	Y

Study	Center	Funding	Adequate Description		Clinic BP Observer			Ambulatory BP Trained	Statistical Variability Reported
			Eligibility	Baseline Characteristics	Trained	Blinded	Standard Technique		
Redon, 1994	single	industry	Y	Y	can't tell	N	Y	can't tell	Y
Redon, 1996	can't tell	can't tell	Y	Y	can't tell	N	Y	can't tell	Y
Schulte, 1993	can't tell	can't tell	N	Y	can't tell	N	can't tell	can't tell	Y
Verdecchia, 1990	single	can't tell	Y	Y	can't tell	Y	can't tell	can't tell	Y
Verdecchia, 1995	multi	other	Y	Y	can't tell	N	can't tell	can't tell	Y
Weber, 1994	single	govt	Y	Y	can't tell	Y	Y	can't tell	Y
Zakopoulos, 1999	can't tell	can't tell	Y	Y	can't tell	N	can't tell	Y	Y

Evidence Table 34: Summary of population characteristics for articles addressing question #3

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Baguet, 2001	200	hypertension clinic	hypertensives	regional wall motion abnormalities on echocardiogram; valvular disease or cardiomyopathy	62		51 (13)	100	0
Bauduceau, 1998	171	other research study	hypertensives; diabetes	age <18 and >75; anti-hypertensive medication; serum creatinine>1500 ml/L	54		62 (10)	100	0
Chen, 1995	1682	general population	hypertensives; normotensives	can't tell			54.8 (13.1)	34.6	
Normotensive	720				51		51.3 (13.4)	0	13
Borderline hypertensive	380				54		58.1 (12.2)	0	40
Hypertensive	582				50		57 (12.4)	100	53
Cuspidi, 2000	100	hypertension clinic	hypertensives; anti-hypertensive medication	active CHD/CVD; obesity; cardiac valve disease; conditions preventing ABPM (afib)	61		56.5 (8.8)	100	100
Devereux, 1983	100	hypertension clinic	hypertensives; normotensives	active CHD/CVD	81		42.4	81	0

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Ferrara, 1997	108	can't tell	hypertensives; normotensives	anti-hypertensive medication; diabetes; chronic renal insufficiency; active CHD/CVD; liver cirrhosis; chronic lung disease; lactation; oral contraceptive use; no echocardiograph	63.9		42.3 (10.2)	70.4	0
Gosse, 1993	204	other specialty clinic	hypertensives	anti-hypertensive medication; active CHD/CVD; secondary hypertension	68.6		50 (11)	100	0
Gosse, 1997	181	hypertension clinic	hypertensives	anti-hypertensive medication; active CHD/CVD; poor quality echocardiograph	70.7		50 (11)	100	0
Hansen, 1992	68	general population	age <50; Type Idiabetes	pregnancy; anti-hypertensive medication	70.6		30.5 (10.2)		0
Hoegholm, 1994	411	general practitioners; general population		anti-hypertensive medication; diabetes; dialysis; chronic renal insufficiency; renal transplant	46.4			69	0
Normotensive	127				50.4		53.4 (15.4)	0	0
Hypertensive	284				44.7			100	0

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Hoegholm, 1999	566	general practitioners; general population	hypertensives; normotensives	anti-hypertensive medication; diabetes; active CHD/CVD	47.5			74.2	0
Jula, 1999	233	general clinic	age between 34 and 55; hypertensives	pregnancy; anti-hypertensive medication; diabetes; active CHD/CVD; valvular heart disease	58.4		46 (4.9)	100	0
Lemne, 1995	138	general population	males	can't tell	100			50	
Normotensives	69				100		49.5 (5.7)	0	
Borderline hypertensives	69				100		50 (5.5)	100	
Manning, 1999	186	hypertension clinic	hypertensives	anti-hypertensive medication;	51.1		46	100	0
Martinez, 1999	345	general clinic	hypertensives	racial groups; normotensives; anti-hypertensive medication; significant concomitant diseases	47.8	0	51.8 (10.6)	100	0
Women	180				0	0		100	0
Men	165				100	0		100	0
Martinez, 2001	223	general clinic	hypertensives	age <18 age >75; normotensives; anti-hypertensive medication; diabetes; chronic renal insufficiency; renal transplant; active CHD/CVD	49.8	0	53 (11)	100	0

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Myers, 1995b	147	primary care family physicians	hypertensives; anti-hypertensive medication	age <21 age >80; dialysis;chronic renal insufficiency;renal transplant; active CHD/CVD	38.1		64	100	100
Men	56				100			100	100
Women	91				0			100	100
Palatini, 1998	1037	can't tell	age between 18 and 45; hypertensives; normotensives	anti-hypertensive medication	72		33.3 (8.6)	90.8	0
Pierdomenico, 1995	100	can't tell	no specific population	anti-hypertensive medication; diabetes; chronic renal insufficiency; active CHD/CVD; limited echocardiograhpic	50		47.8 (10.0)	75	0
Pose-Reino, 1996	102	other specialty clinic	hypertensives; normotensives	anti-hypertensive medication; active CHD/CVD; clinic DBP >104 mmHg	52.9			50	0
Redon, 1994	127	can't tell	age between 25 and 50; hypertensives; normotensives	anti-hypertensive medication; diabetes; chronic renal insufficiency; GFR< 80ml/min/1.73m^2	64.6		38.9 (73)		0
Redon, 1996	151	can't tell	age between 25 and 50; hypertensives; normotensives;	anti-hypertensive medication; diabetes; chronic renal insufficiency; GFR< 80ml/min/1.73m^2	63.6		37 (8)		0

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Schulte, 1993	142	can't tell	hypertensives; normotensives	unknown	51.4		49	68.3	0
Normotensive	45				53.3		46 (8)	0	0
Hypertensive	97				50.5		47.5 (9)	100	0
Verdecchia, 1990	235	can't tell	no specific population	anti-hypertensive medication; active CHD/CVD				58.3	0
Normotensive	98				51		51.9 (14)	0	0
Hypertensive	137				53		52.5 (11)	100	0
Verdecchia, 1995	1414	can't tell	no specific population	congestive heart failure; valvular disease; concomitant disease	44.8		50 (12)	87.4	0
Weber, 1994	259	hypertension clinic	no specific population	anti-hypertensive medication; diabetes; chronic renal insufficiency; active CHD/CVD; hepatic disorder	84.6			66	0
Zakopoulos, 1999	153	can't tell	hypertensives	normotensives; anti-hypertensive medication; active CHD/CVD	54.2			100	0

Evidence Table 35: Summary of clinic measurement characteristics for articles addressing question #3

Study	Device Type	Observer	Position	Measurements (Number)		
				Per Day	Days	Total
Baguet, 2001	mercury	can't tell	supine	1	3	3
Bauduceau, 1998	mercury	physician	sitting	3	1	3
Chen, 1995	can't tell	physician	sitting	2	1	2
Cuspidi, 2000	mercury	physician	sitting	3	1	3
Devereux, 1983	can't tell	physician	can't tell	can't tell		
Ferrara, 1997	automated	can't tell	supine	2	3	6
Gosse, 1993	mercury	physician	supine	3	1	3
Gosse, 1997	mercury	physician	supine	3	1	3
Hansen, 1992	mercury random zero	can't tell	sitting	3	1	3
Hoegholm, 1994	multiple devices	can't tell	sitting	can't tell		
Hoegholm, 1999	multiple devices	can't tell	sitting	can't tell		
Jula, 1999	mercury	nurse	sitting	2	4	8
Lemne, 1995	mercury	nurse	can't tell	can't tell		
Manning, 1999	mercury	can't tell	combination	3	3	9
Martinez, 1999	mercury	nurse, physician	sitting	2	3	6
Martinez, 2001	mercury	physician	sitting	2	3	6
Myers, 1995b	mercury	nurse	sitting	3	2	6
Palatini, 1998	can't tell	can't tell	supine	3	2	6
Pierdomenico, 1995	can't tell	can't tell	supine	3	1	3
Pose-Reino, 1996	can't tell	can't tell	can't tell	can't tell		
Redon, 1994	mercury	can't tell	sitting	3	1	3
Redon, 1996	mercury	can't tell	sitting	3	3	9
Schulte, 1993	can't tell	can't tell	can't tell	can't tell		
Verdecchia, 1990	mercury random zero	can't tell	supine	can't tell		
Verdecchia, 1995	can't tell	can't tell	can't tell	can't tell		
Weber, 1994	can't tell	can't tell	sitting	1	3	3

Study	Device Type	Observer	Position	Measurements (Number)		
				Per Day	Days	Total
Zakopoulos, 1999	can't tell	can't tell	can't tell	3	3	9

Evidence Table 36: Summary of ambulatory blood pressure measurement for articles addressing question #3

Study	Device			Daytime		Nighttime	
	Type	Name	Validated	Definition	Time Interval (mins)	Definition	Time Interval (mins)
Baguet, 2001	oscillometric	SpaceLabs 90207	Y	7:00am - 10:00pm	15	10:00pm - 7:00am	15
Bauduceau, 1998	oscillometric	SpaceLabs 90207	Y	7:00am - 10:00pm	15	10:00pm - 7:00am	15
Chen, 1995	oscillometric	SpaceLabs 90207	Y	7:00am - 10:00pm	20	11:00pm - 6:00am	60
Cuspidi, 2000	oscillometric	SpaceLabs 90207	Y	7:00am - 11:00pm	15	11:00pm - 7:00am	20
Devereux, 1983	unknown	Pressurometer II	unknown	patient reported	15	patient reported	15
Ferrara, 1997	oscillometric	SpaceLabs 90207	Y	7:00am - 10:45pm	15	11:00pm - 6:40am	20
Gosse, 1993	auscultatory unknown	DIASYS 200 SpaceLabs 5200	N unknown	6:00pm - 10:00am	15	10:00pm - 6:00am	can't tell
Gosse, 1997	auscultatory unknown	DIASYS 200 SpaceLabs 5200	N unknown	6:00am - 10pm	15	10:00pm - 6:00pm	can't tell
Hansen, 1992	oscillometric	SpaceLabs 90202	Y	6:00am - 12:00pm	20	12:00pm - 6:00am	60
Hoegholm, 1994	unknown	TM-2420 (no model specified)	unknown	7:00am - 10:59pm	15	11:00pm - 6:59am	30
Hoegholm, 1999	oscillometric oscillometric	TM-2420, Model 7 TM-2420, Model 6	Y Y	8:00am - 9:59pm	15	12:00am - 5:59am	30
Jula, 1999	auscultatory	Accutracker II	N	6:00pm - 11:00am	15	11:00pm - 6:00am	30
Lemne, 1995	auscultatory	Pressurometer IV	unknown	patient reported	15	patient reported	15
Manning, 1999	auscultatory	Medilog ABP	N	patient reported	30	patient reported	30
Martinez, 1999	oscillometric	SpaceLabs 90207	Y	10:00am - 8:00pm	15	12:00pm - 6:00am	15
Martinez, 2001	oscillometric	SpaceLabs 90207	Y	10:00am - 8:00am	15	12:00am - 6:00am	30
Myers, 1995b	oscillometric oscillometric	SpaceLabs 90202 SpaceLabs 90207	Y Y	can't tell	15	not measured	not measured
Palatini, 1997	oscillometric oscillometric	SpaceLabs 90207 TM-2420, Model 7	Y Y	6:00am - 11:00pm	10	11:00pm - 6:00am	15

Study	Device			Daytime		Nighttime	
	Type	Name	Validated	Definition	Time Interval (mins)	Definition	Time Interval (mins)
Palatini, 1998	oscillometric oscillometric	SpaceLabs 90207 TM-2420, Model 7	Y Y	can't tell	10	can't tell	30
Pierdomenico, 1995	oscillometric	SpaceLabs 90207	Y	6:00am - 12:00am	15	12:00am - 6:00am	30
Pose-Reino, 1996	auscultatory	Accutracker II	N	8:00am - 10:00pm	20	10:00pm - 8:00am	30
Redon, 1994	oscillometric oscillometric	SpaceLabs 90202 SpaceLabs 90207	Y Y	6:00am - 12:00pm	20	12:00pm - 6:00am	30
Redon, 1996	oscillometric oscillometric	SpaceLabs 90202 SpaceLabs 90207	Y Y	6:00am - 12:00pm	20	12:00pm - 6:00am	30
Schulte, 1993	oscillometric	SpaceLabs 90207	Y	patient reported	15	patient reported	30
Verdecchia, 1990	unknown	SpaceLabs 5200	unknown	6:00am - 10:00pm	15	8:00pm - 6:00am	15
Verdecchia, 1995	oscillometric oscillometric unknown	SpaceLabs 90202 SpaceLabs 90207 SpaceLabs 5200	Y Y unknown	6:00pm - 10:00pm	15	10:00pm - 6:00am	15
Weber, 1994	oscillometric	SpaceLabs 90207	Y	6:00am - 10:00pm	15	10:00pm - 6:00am	15
Zakopoulos, 1999	oscillometric	SpaceLabs 90207	Y	6:00am - 10:00pm	15	10:00pm - 6:00am	15

Evidence Table 37: Characteristics of measures of left ventricular mass (question #3)

Study	Left ventricular mass		Left ventricular hypertrophy	
	Units	Mean (SD)	Criteria	Prevalence (%)
Baguet, 2001	LV mass by surface area (g/m^2)	108 (26)	not applied	unknown
Chen, 1995	LV mass by surface area (g/m^2)			
Borderline hypertensive		92.4 (18.5)	not applied	unknown
Hypertensive		99.5 (20.1)	not applied	unknown
Normotensive		85.4 (25.3)	not applied	unknown
Cuspidi, 2000	LV mass by surface area (g/m^2)	unknown	125 males 100 females	28
Devereux, 1983	LV mass by surface area (g/m^2)	104.9 (26.2)	not applied	unknown
Ferrara, 1997	LV mass by height$^{2.7}$ ($g/m^{2.7}$)	43.1 (10.2)	not applied	unknown
Gosse, 1993	LV mass by height (g/m)	140	not applied	unknown
Gosse, 1997	LV mass by surface area (g/m^2)	122 (31)	not applied	unknown
Hoegholm, 1999	unknown (g/m^2)	unknown	not applied	unknown
Jula, 1999	LV mass by surface area (g/m^2)	111(25)	not applied	unknown
Lemne, 1995	LV by height^2 (g/m^2)		134	
Borderline hypertensives		114 (22)		16
Normotensives		109 (22)		12
Manning, 1999	LV mass by surface area (g/m^2)	119.8 (31)	132 males 110 females	36.1
Martinez, 1999	LV mass by surface area (g/m^2)		not applied	unknown
Men		124.0 (26.9)	not applied	unknown
Women		103.4 (18.8)	not applied	unknown
Myers, 1995b	LV mass by surface area (g/m^2)	109	not applied	unknown
Palatini, 1998	LV mass by surface area (g/m^2)	89.1		unknown
Pierdomenico, 1995	LV by height^2 (g/m^2)	110.8 (10.1)	not applied	unknown

Study	Left ventricular mass		Left ventricular hypertrophy	
	Units	Mean (SD)	Criteria	Prevalence (%)
Pose-Reino, 1996	LV mass by surface area (g/m^2)	unknown	134 males 110 females	unknown
Redon, 1996	LV mass by height (g/m)	140.6 (44.1)	140 males 120 females	34
Schulte, 1993	LV mass by surface area (g/m^2)	unknown	135 males 110 females	unknown
Normotensive		93.1(21.4)	not applied	0
Hypertensive		137.2 (28.4)	not applied	51.5
Verdecchia, 1990	LV mass by surface area (g/m^2)	unknown	not applied	unknown
Hypertensive		unknown	not applied	unknown
Normotensive		82.4 (31)	not applied	unknown
Verdecchia, 1995	LV mass by surface area (g/m^2)	unknown	not applied	unknown
Weber, 1994	LV mass by surface area (g/m^2)	unknown	not applied	unknown
Zakopoulos, 1999	LV mass by surface area (g/m^2)	125.4 (47.2)	not applied	unknown

Evidence Table 38: Correlation of clinic and ambulatory blood pressure with left ventricular mass (question #3)

Study	Correlations with Systolic BP (P-value)				Correlations with Diastolic BP (P-value)				Adjustment factors	Multivariate Model
	Clinic	24 hr	Daytime	Nighttime	Clinic	24 hr	Daytime	Nighttime		
Baguet, 2001	0.34 (<0.001)	0.37 (<0.001)	0.35 (<0.001)	0.37 (<0.001)	0.25 (<0.001)	0.28 (<0.001)	0.23 (<0.001)	0.29 (<0.001)	unadjusted	Y
Chen, 1995	0.34 (<0.01)	0.43 (<0.01)	0.42 (<0.01)	0.41 (<0.01)	0.2 (<0.01)	0.32 (<0.01)	0.33 (<0.01)	0.29 (<0.01)	unadjusted	Y
Borderline hypertensive	0.16 (<0.01)	0.27 (<0.01)	0.26 (<0.01)	0.24 (<0.01)	-0.13 (>0.05)	0.07 (>0.05)	0.07 (>0.05)	0.06 (>0.05)	unadjusted	Y
Normotensive	0.16 (<0.01)	0.31 (<0.01)	0.31 (<0.01)	0.29 (<0.01)	-0.01 (>0.05)	0.16 (<0.01)	0.19 (<0.01)	0.14 (<0.01)	unadjusted	Y
Hypertensive	0.25 (<0.01)	0.39 (<0.01)	0.38 (<0.01)	0.37 (<0.01)	0.04 (>0.05)	0.25 (<0.01)	0.26 (<0.01)	0.22 (<0.01)	unadjusted	Y
Cuspidi, 2000	0.13 (>0.05)	0.35 (<0.01)	0.30 (<0.01)	0.32 (<0.01)	0.11 (>0.05)	0.38 (<0.01)	0.36 (<0.01)	0.34 (<0.01)	unadjusted	N
Devereux, 1983	0.24 (<0.05)	0.38 (<0.001)		0.10 (>0.05)	0.20 (<0.05)	0.31 (<0.01)		0.24 (<0.05)	unadjusted	N
Gosse, 1993	0.18 (<0.01)		0.30 (<0.001)		0.2 (<0.01)		0.18 (<0.01)		unadjusted	Y
Gosse, 1997	0.24 (<0.01)	0.39 (<0.001)			0.18 (<0.05)	0.26 (<0.001)			age	Y
Jula, 1999	0.4 (<0.001)	0.44 (<0.001)	0.46 (<0.001)	0.35 (<0.001)	0.37 (<0.001)	0.37 (<0.001)	0.37 (<0.001)	0.32 (<0.001)	unadjusted	Y
Lemne, 1995										
Normotesive	0.03 (>0.05)	0.28 (<0.05)	0.22 (>0.05)		0.14 (>0.05)	0.21 (>0.05)	0.15 (>0.05)		unadjusted	N
Borderline hypertensive	0.23 (>0.05)	0.49 (<0.001)	0.52 (<0.001)		0.02 (>0.05)	0.16 (>0.05)	0.16 (>0.05)		unadjusted	N
Martinez, 1999										

Study	Correlations with Systolic BP (P-value)				Correlations with Diastolic BP (P-value)				Adjustment factors	Multivariate Model
	Clinic	24 hr	Daytime	Nighttime	Clinic	24 hr	Daytime	Nighttime		
Men	0.26	0.18 (>0.05)	0.13 (>0.05)	0.11 (>0.05)	0.02 (>0.05)	0.14 (>0.05)	0.09 (>0.05)	0.09 (>0.05)	unadjusted	N
Women	0.17 (>0.05)	0.43 (<0.01)	0.38 (<0.01)	0.37 (<0.01)	0.06 (>0.05)	0.34 (<0.01)	0.24 (<0.01)	0.37 (<0.01)	unadjusted	N
Myers, 1995b	0.23 (<0.01)		0.24 (<0.01)		0.02 (>0.05)		0.09 (>0.05)		unadjusted	N
Redon, 1996	0.24 (<0.05)	0.41 (<0.05)			0.19 (>0.05)	0.3 (<0.05)			unadjusted	Y
Schulte, 1993	0.52 (<0.001)	0.55 (<0.001)	0.56 (<0.001)	0.5 (<0.001)	0.46 (<0.001)	0.51 (<0.001)	0.52 (<0.001)	0.43 (<0.001)	unadjusted	N
Normotensive	0.28 (>0.05)	0.33 (<0.05)	0.37 (<0.05)	0.21 (>0.05)	0.3 (>0.05)	0.29 (>0.05)	0.2 (>0.05)	0.19 (>0.05)	unadjusted	N
Hypertensive	0.37 (<0.01)	0.48 (<0.001)	0.45 (<0.001)	0.44 (<0.001)	0.21 (>0.05)	0.35 (<0.001)	0.41 (<0.001)	0.38 (<0.001)	unadjusted	N
Verdecchia, 1990	0.38 (<0.01)	0.48 (<0.01)	0.4 (<0.01)	0.47 (<0.01)	0.29 (<0.01)	0.36 (<0.01)	0.28 (<0.01)	0.37 (<0.01)	unadjusted	Y
Normotensive	0.36 (<0.01)	0.33 (<0.01)	0.31 (<0.01)	0.29 (<0.01)	0.02 (<0.01)	0.15 (<0.01)	0.16 (<0.01)	0.17 (<0.01)	unadjusted	Y
Hypertensive	0.33 (<0.01)	0.51 (<0.01)	0.38 (<0.01)	0.51 (<0.01)	0.27 (<0.01)	0.34 (<0.01)	0.2 (<0.01)	0.35 (<0.01)	unadjusted	Y
Zakopoulos, 1999	0.33 (<0.001)	0.35 (<0.001)			0.19 (<0.01)	0.32 (<0.001)			unadjusted	Y

Evidence Table 39: Correlation of left ventricular mass with ambulatory blood pressure defined white coat hypertension (question #3)

Study	Cut-off values for HTN		Distribution of BP (%)			LV mass				Comparison (P-value)		Adjustment factors	Multivariate Model
	Clinic	ABPM	NT	WCH	SH	Units	Mean (SD)			WCH vs NT	SH vs WCH		
							NT	WCH	SH				
Ferrara, 1997	SBP > 140 DBP > 90	SBP > 130 DBP > 85	29.6	18.5	51.9	$g/m^{2.7}$	41.5 (10)	41.5 (11)	44.5 (10)	0	3	unadjusted	N
Hoegholm, 1999	DBP > 91	SBP > 135 DBP > 90		13.4		g/m^2	98.2 (29.1)	89.7 (18.9)	107.5 (28.5)	-8.5	17.8	unadjusted	N
Manning, 1999	SBP > 140 DBP > 90	SBP > 137 DBP > 87		22.6	77.4	g/m^2		102 (23)	125 (33)		23 (<0.001)	unadjusted	N
Martinez, 1999	SBP > 140 DBP > 90	SBP > 135 DBP > 85		39.4	60.6	g/m^2				NA	7.6	age, gender,BMI, duration of HTN	Y
Men				30.1	69.9	g/m^2		122.3 (27.7)	124.8 (26.6)	NA	2.5	unadjusted	N
Women				47.4	52.6	g/m^2		98.9 (18.9)	108.2 (18.8)	NA	9.3	unadjusted	N
Myers, 1995b				61.9	38.1	g/m^2		112	108	NA	-4 (>0.05)	unadjusted	N
Palatini, 1998	SBP > 140 DBP > 90	SBP > 135 DBP > 85	11.6	31.8	56.5	g/m^2	82.1 (1.85)	89.1 (16.1)	93.8 (17.2)	7 (<0.001)	4.7 (<0.001)	BMI	Y
Pierdomenico, 1995	SBP > 140 DBP > 90	SBP > 135 DBP > 85	25	25	50	g/m^2	93.9 (11)	97.6 (11.5)	125.9 (20)	3.7	28.3 (<0.05)	unadjusted	N
Pose-Reino, 1996	SBP > 140 DBP > 90	SBP > 135 DBP > 85	50	26.5	23.5	g/m^2	106 (25)	132 (46)	142 (45)	26	10	unadjusted	Y
Verdecchia, 1995	SBP > 140 DBP > 90		11.8	16.7	71.5	g/m^2	87 (17)	93 (23)	112 (31)	6	19	unadjusted	N
Weber, 1994	DBP > 90	DBP > 85		22.4		g/m^2	122	126.5	130	4.5	8	unadjusted	N

Evidence Table 40: Characteristics of albuminuria measurement (question #3)

Study	Measurement	Collection Period	Mean (SD)	Micro-albuminuria	
				Criteria [a]	Prevalence (%)
Bauduceau, 1998	mg/24hrs	24 hours	unknown	30	43.3
Hansen, 1992	mg/24hrs	can't tell	40.9 (1.9)	28.8	50
Hoegholm, 1994	mg/mg creatinine	spot	unknown	0.5	unknown
Jula, 1999	mg/24hrs	24 hours	25.7 (39.3)	NA	unknown
Martinez, 1999	mg/24hrs	8 hours for 3 days	9.5	28.8	unknown
Martinez, 2001	mg/24hrs	8 hours for 3 days	unknown	28.8	7.2
Palatini, 1998	log (mg/24hrs)	24 hours	unknown	30	unknown
Pierdomenico, 1995	mg/24hrs	24 hours	unknown	30	unknown
Redon, 1996	mg/24hrs	24 hours for 2 days	25.1 (38.6)	30	24.4
Redon, 1994	mg/24hrs	24 hours for 2 days	30.1 (52.3)	30	28

[a] criteria same for females and males in each study

Evidence Table 41: Correlations of clinic and ambulatory blood pressure with albuminuria (question #3)

Study	Correlations with Systolic BP (P-value)				Correlations with Diastolic BP (P-value)				Adjustment factors	Multivariate Model
	Clinic	24 hr	Daytime	Nighttime	Clinic	24 hr	Daytime	Nighttime		
Hansen, 1992	0.21 (0.09)		0.45 (<0.001)	0.53 (<0.001)					unadjusted	Y
Hoegholm, 1994										Y
Normotensives	0.23 (<0.01)		0.2	0.19 (>0.05)	0.26 (<0.01)		0.15	0.22 (<0.01)	unadjusted	
Hypertensives	0.11		0.21 (<0.001)	0.28 (<0.001)	-0.05		0.09 (>0.05)	0.19 (<0.01)	unadjusted	
Jula, 1999	0.34 (<0.001)	0.32 (<0.001)	0.33 (<0.001)	0.25 (<0.001)	0.25 (<0.001)	0.23 (<0.001)	0.24 (<0.001)	0.16 (<0.05)	unadjusted	N
Martinez, 2001	0.09 (>0.05)	0.22 (<0.01)	0.15 (<0.05)	0.33 (<0.01)	0.05 (>0.05)	0.2 (<0.01)	0.2 (<0.01)	0.27 (<0.01)	unadjusted	Y
Redon, 1994	0.1 (>0.05)	0.34 (>0.05)			0.16 (>0.05)	0.34 (>0.05)			unadjusted	Y
Redon, 1996	0.31 (<0.05)	0.37 (<0.05)			0.31 (<0.05)	0.38 (<0.05)			unadjusted	N

Evidence Table 42: Correlation of ambulatory blood pressure defined white coat hypertension with albuminuria (question #3)

Study	Cut-off values for HT		Distribution of hypertension (%)			Units	Mean albuminuria (SD)			Comparison (P-value)		Adjustment factors	Multivariate Model
	Clinic	ABP	NT	WCH	SH		NT	WCH	SH	WCH vs NT	SH vs WCH		
Bauduceau, 1998	DBP > 90	SBP > 139 DBP> 87		73.7	26.3	mg/24hrs		22	44		22 (<0.01)	unadjusted	Y
Hoegholm, 1994	DBP > 90	DBP > 90		27	42	mg/24hrs creatinine	20.9 (69.4)	22 (38.6)	51.2 (177)			unadjusted	
Hoegholm, 1999	DBP > 91	SBP > 135 DBP > 90		13.4	60.7	log (mg/24hrs creatinine)	-0.161 (0.357)	-0.067 (0.386)	0.104 (0.466)	(<0.05)	(<0.05)	unadjusted	Y
Martinez, 1999	SBP > 140 DBP > 90	SBP > 135 DBP > 85		39.4	60.6	mg/24hrs		7.1	11.8		4.7	unadjusted	N
Martinez, 2001	SBP > 140 DBP > 90			32.2	67.7	mg/24hrs		7.2 (2.9)	9.6 (2.9)		2.4 (<0.05)	unadjusted	Y
Palatini, 1998	SBP > 140 DBP > 90	SBP > 135 DBP > 85	11.6	31.8	56.5	log (mg/24hrs)		0.67 (0.48)	0.76 (0.43)			BMI	N
Pierdomenico, 1995	SBP > 140 DBP > 90	SBP > 135 DBP > 85	25	25	50	mg/24hrs	4.31 (1.1)	4.45 (1.48)	15.1 (13.8)	0.2 (>0.05)	10.6 (<0.001)	unadjusted	N

Evidence Table 43: Summary of quality characteristics for prospective studies addressing question #3 (question #3b)

Study	Centers	Funding	Adequate description		Clinic BP Observer			Ambulatory BP Trained	Blinded Outcome Assessment	Follow up data for ≥80%	Statistical Variability Reported
			Eligibility	Baseline Characteristics	Trained	Blinded	Standard Technique				
Amar, 2000	single	can't tell	Y	Y	can't tell	N	Y	Y	N	Y	Y
Fagard, 2000	multi	govt, industry	N	Y	can't tell	Y	can't tell	can't tell	Y	Y	Y
Gosse, 1997	single	can't tell	Y	Y	can't tell	N	can't tell	can't tell	N	Y	Y
Nakano, 1999	single	other	N	Y	can't tell	N	can't tell	can't tell	N	N	Y
Ohkubo, 1997a	single	govt, other	Y	Y	can't tell	N	can't tell	can't tell	Y	Y	Y
Ohkubo, 1997b	single	govt, other	Y	Y	can't tell	N	Y	can't tell	Y	Y	Y
Ohkubo, 2000	single	govt, other	Y	Y	can't tell	N	Y	can't tell	Y	Y	Y
Perloff, 1989	single	govt, other	N	Y	can't tell	N	Y	can't tell	N	Y	Y
Redon, 1998	single	can't tell	Y	Y	can't tell	Y	Y	can't tell	N	Y	Y
Staessen, 1999	multi	govt, industry, other	Y	Y	can't tell	N	can't tell	can't tell	Y	Y	Y
Suzuki, 2000	single	can't tell	Y	Y	Y	N	can't tell	can't tell	N	Y	Y
Verdecchia, 1994	single	can't tell	Y	Y	can't tell	Y	Y	can't tell	Y	Y	Y

Study	Centers	Funding	Adequate description		Clinic BP Observer			Ambulatory BP Trained	Blinded Outcome Assessment	Follow up data for ≥80%	Statistical Variability Reported
			Eligibility	Baseline Characteristics	Trained	Blinded	Standard Technique				
Verdecchia, 1998	single	can't tell	Y	Y	can't tell	N	Y	can't tell	Y	Y	Y
Zweiker, 1994	single	can't tell	N	Y	can't tell	N	can't tell	Y	N	Y	Y

Evidence Table 44: Summary of population characteristics for prospective studies of ambulatory blood pressure measurement (question #3b)

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Amar, 2000	57	other specialty clinic	anti-hypertensive medication;dialysis	orthstatic hypotension; autonomic dysfunction	52.6		56.8	100	100
Fagard, 2000	695	Syst-Eur Trial	age >59 ; hypertensives; isolated systolic hypertension	can't tell	37.6		70	100	
Gosse, 1997	134	other specialty clinic other research study	age >45 ; hypertensives	diabetes; active CHD/CVD	56.7		61(11)	100	0
Nakano, 1999	257	Hospital	Type II diabetes		63			51	0
Ohkubo, 1997a	1542	general population	age >39	demented; bedridden; hospitalized	36.6		61.5		30.7
Ohkubo, 1997b	1542	general population	age >40	demented; bedridden; hospitalized	36.6		61.5		30.7
Ohkubo, 2000	1476	general population	age >40	demented; bedridden, hospitalized; prior stroke	40		61		27.4
Perloff, 1989	761	hypertension clinic	no specific population	dialysis; renal transplant	47.6		43.1		0
Redon, 1998	86	hypertension clinic	hypertensives; poorly controlled HTN on > 3 meds	diabetes; chronic renal insufficiency; secondary hypertension	29.1		53.3	100	100
Staessen, 1999	265	Syst-Eur Trial	age >60; hypertensives	chronic renal insufficiency	38.5		69.6 (6.2)	100	0

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Suzuki, 2000	134	general population	elderly	autonomic dysfunction; physical disability	50		78.5 (7)	100	100
Verdecchia, 1994	1392	general clinic	hypertensives; normotensives	heart failure; valvular; heart disease	50.3	51.3		85.3	
Male	479				100		51.72		
Female	480				0		54.15		
Verdecchia, 1998	2010	general clinic	hypertensives	anti-hypertensive medication; secondary cause of hypertension	52	0	52 (12)	100	0
Zweiker, 1994	116	general clinic	hypertensives	can't tell	42.2		59 (13)		

Evidence Table 45: Summary of methods for prospective studies of ambulatory blood pressure measurement (question #3b)

Study	Follow-up-Years mean (SD)	N	Outcomes			Analyses Adjusted for	Comparison of Prediction
			n	Outcome	Description		
Amar, 2000	2.9 (1.7)	57	10	CVD Mortality	Ischemic heart disease, Stroke, Aortoiliac disease, Congestive heart failure, Sudden death	Age, Gender, Prior CVD	Not Tested
Fagard,[a] 2000		695	79	CVD Morbidity and Mortality	Sudden death, Stroke, MI, Heart failure	Gender, Prior CVD	Not Tested
			29	Stroke	Neurologic deficit lasting >24 hours or causing death		
Gosse, 1997	2.5 (0.7)	134	14	CVD Morbidity and Mortality	Stroke, MI, Angina, Heart failure, Renal failure, Lower limb arterial disease		ABP better than Clinic BP, by discriminant function analyses
Nakano, 1999	4.2	257	22	Dialysis	Incident hemodialysis	Age, Gender, Smoking, Blood pressure, Glycemic control, Duration of diabetes, Serum protein, Serum creatinine.	ABP better than Clinic BP, by stepwise regression analyses

Study	Follow-up-Years mean (SD)	N	Outcomes			Analyses Adjusted for	Comparison of Prediction
			n	Outcome	Description		
Ohkubo,[b] 1997a	5.1 (2)	1542	93	Total Mortality	Total mortality	Age, Gender, Smoking, Anti hypertensive medications, Prior CVD	Not tested
			37	CVD Mortality	CVD Mortality		
Ohkubo,[b] 1997b	5.1 (2)	1542	93	Total Mortality	Total mortality	Age, Gender, Smoking, Anti hypertensive medications, Prior CVD	ABP better than Clinic BP, by stepwise regression analyses
			37	CVD Mortality	CVD Mortality		
Ohkubo,[b] 2000	6.4 (2)	1476	74	Stroke	Stroke or TIA	Age, Gender, Smoking, Cholesterol, Hematocrit, Prior CVD, Diabetes, BP medication	ABP better than Clinic BP, by stepwise regression analyses
Perloff, 1989	5.5 (3.5)	761	120	CVD Morbidity and Mortality	Cardiac, Cerebral and peripheral vascular diseases, Aortic dissection, Retinal vascular changes, Renal function decline, Heart failure	Age, Gender, LVH, BP medication, Optic fundus.	Incremental Gain of ABP over clinic BP, by residual model
Redon, 1998	4	86	21	CVD Morbidity and Mortality	MI, Angina, Coronary Revascularization, Stroke, TIA, Sudden death, Aortoiliac occlusive disease, Heart failure, Hypertensive emergencies	Prior CVD	ABP better than Clinic BP, by stepwise regression analyses

Study	Follow-up-Years mean (SD)	N	Outcomes			Analyses Adjusted for	Comparison of Prediction
			n	Outcome	Description		
Staessen,[a] 1999	4.4 [median]	265	39	Total Mortality	Total mortality	Age, Gender, Smoking, Prior CVD	Incremental Gain of ABP over clinic BP, by regression analyses with both variables entered in models
			22	CVD Mortality	CVD mortality		
			54	CVD Morbidity and Mortality	Fatal and Non fatal heart failure, MI, Sudden death, Stroke		
			20	Stroke	Fatal and non fatal stroke		
			35	Cardiac Morbidity and Mortality	Fatal and non fatal heart failure, MI		
Suzuki, 2000	4.3 (1.8)	134	34	CVD Morbidity and Mortality	MI, Angina, Cerebral infarction, Cerebral hemorrhage, TIA, Sudden death, Heart failure, Renal failure	Age, Gender, Smoking, Diabetes, LVH, Prior CVD	ABP better than Clinic BP, by stepwise regression analyses
Verdecchia,[c] 1994	3.2	1392	89	CVD Morbidity and Mortality	MI, Stroke, Sudden death, Heart failure, Stroke, TIA, Coronary revascularization, Angina, Ischemic changes on ECG, Aortoiliac occlusive disease, Retinal artery occlusion, Renal failure	Age, Diabetes, Prior CVD, Pulse Pressure, Clinic DBP, Smoking, Cholesterol, BMI, LVH	Not tested

Study	Follow-up-Years mean (SD)	N	Outcomes			Analyses Adjusted for	Comparison of Prediction
			n	Outcome	Description		
Verdecchia,[c] 1998	3.8 (2.4)	2010	36	CVD Morbidity and Mortality	New onset coronary artery disease, Stroke, TIA, Aortoiliac occlusive disease, Retinal artery occlusion, Heart failure, Renal failure	Age, Gender, Smoking, BMI, Smoking, Cholesterol, BP medications, LVH	ABP better than Clinic BP, by stepwise regression analyses
Zweiker, 1994	2.6	116	4	Total Mortality	Total mortality		Not tested
			5	CVD Morbidity and Mortality	MI, Apoplexy, TIA		

[a] One of two papers from Syst-Eur trial [b] One of three papers from Ohasama study [c] One of the two papers from PIUMA study

Evidence Table 46: Prediction of outcome by clinic blood pressure and systolic ambulatory blood pressure (question #3b)

Study	Outcome	Contrast	Clinic		Day Time		Night Time		24 Hour	
			Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value
Amar, 2000	CVD Mortality	Per 10 mmHg	0.99	0.94	1.38	0.08	1.41	0.01	1.37	0.09
Goose, 1997	CVD Morbidity and Mortality	Per mmHg							1.03[d]	0.02
Ohkubo,[b] 1997b	Total Mortality	2nd VS 1st Quintile	0.95[e]	NS	0.7[e]	NS	1.1[e]	NS	0.59[e]	NS
		3rd VS 1st Quintile	0.96[e]	NS	0.54[e]	NS	0.43[e]	NS	0.49[e]	NS
		4th VS 1st Quintile	0.55[e]	NS	0.75[e]	NS	0.66[e]	NS	0.5[e]	NS
		5th VS 1st Quintile	1.23[e]	NS	1.08[e]	NS	1.37[e]	NS	1.15[e]	NS
Ohkubo,[b] 1997b	CVD Mortality	2nd VS 1st Quintile	1.09[e]	NS	0.14[e]	NS	1.35[e]	NS	0.34[e]	NS
		3rd VS 1st Quintile	1.63[e]	NS	0.64[e]	NS	1.62[e]	NS	0.39[e]	NS
		4th VS 1st Quintile	0.78[e]	NS	1.08[e]	NS	1.68[e]	NS	0.59[e]	NS
		5th VS 1st Quintile	1.77[e]	NS	1.26[e]	NS	4[e]	NS	1.58[e]	NS

Study	Outcome	Contrast	Clinic		Day Time		Night Time		24 Hour	
			Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value
Ohkubo,[b] 2000	Stroke	Per 10 mmHg	1.02 - 1.06	NS	1.41	0.0001	1.34	0.0007	1.47	0.0001
Perloff, 1998	CVD Morbidity and Mortality	140-159 VS <140 mmHg	2.17[d,e]	0.047	2.47[d,e]	<0.001				
		160-179 VS <140 mmHg	3.32[d,e]	0.001	4.37[d,e]	<0.001				
		>180 VS <140 mmHg	7.13[d,e]	<0.001	6.13[d,e]	<0.001				
Redon, 1998	CVD Morbidity and Mortality	Middle VS Lowest Tertile			3.69	0.098				
		Highest VS Lowest Tertile			6.42	0.017				

Study	Outcome	Contrast	Clinic		Day Time		Night Time		24 Hour	
			Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value
Staessen,[a] 1999	Total Mortality	Per 10 mmHg	1.21	NS	1.18	NS	1.24	<0.05	1.23	<0.05
	CVD Mortality	Per 10 mmHg	1.29	NS	1.3	<0.05	1.42	<0.01	1.34	<0.05
	CVD Morbidity and Mortality	Per 10 mmHg	1.09	NS	1.19	<0.05	1.31	<0.001	1.26	<0.01
	Stroke	Per 10 mmHg	1.3	NS	1.51	<0.01	1.3	<0.05	1.47	<0.01
	Cardiac Morbidity and Mortality	Per 10 mmHg	1.05	NS	1.07	NS	1.27	<0.05	1.14	NS
Suzuki, 2000	CVD Morbidity and Mortality	Per 10 mmHg		NS		NS	1.34	<0.01	1.28	<0.05
Verdecchia,[c] 1998	CVD Morbidity and Mortality	Per 10 mmHg	1.12	0.004					1.23	0.005

[a] One of two papers from Syst-Eur trial [b] One of three papers from Ohasama study [c] One of the two papers from PIUMA study
[d] Unadjusted [e] Calculated from data in paper

Evidence Table 47: Prediction of outcome by clinic blood pressure and diastolic ambulatory blood pressure (question #3b)

Study	Outcome	Contrast	Clinic		Day Time		Night Time		24 Hour	
			Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value
Amar, 2000	CVD Mortality	Per 10 mmHg	0.49	0.03	1.04	0.89	1.4	0.19	0.93	0.84
Ohkubo,[a] 1997b	Total Mortality	2nd VS 1st Quintile	1.07[c]	NS	0.47[c]	NS	1.56[c]	NS	0.69[c]	NS
		3rd VS 1st Quintile	0.92[c]	NS	0.82[c]	NS	0.84[c]	NS	0.73[c]	NS
		4th VS 1st Quintile	0.87[c]	NS	0.73[c]	NS	0.68[c]	NS	0.7[c]	NS
		5th VS 1st Quintile	1.27[c]	NS	0.98[c]	NS	1.77[c]	NS	1.08[c]	NS
Ohkubo,[a] 1997b	CVD Morbidity and Mortality	2nd VS 1st Quintile	1.34[c]	NS	0.35[c]	NS	1.29[c]	NS	0.63[c]	NS
		3rd VS 1st Quintile	1.87[c]	NS	1.45[c]	NS	1.05[c]	NS	1.3[c]	NS
		4th VS 1st Quintile	1.28[c]	NS	1.24[c]	NS	1.05[c]	NS	1.44[c]	NS
		5th VS 1st Quintile	2.21[c]	NS	1.61[c]	NS	3.95[c]	NS	2.13[c]	NS
Ohkubo,[a] 2000	Stroke	Per 5 mmHg	1.05 - 1.09	NS	1.31	0.0004	1.24	0.0051		

Study	Outcome	Contrast	Clinic		Day Time		Night Time		24 Hour	
			Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value	Estimate (RR)	P-value
Perloff, 1998	CVD Morbidity and Mortality	90-99 VS <90 mmHg	2.78[b,c]	0.009	1.24[b,c]	0.31				
		100-109 VS <90 mmHg	2.42[b,c]	0.031	1.45[b,c]	0.12				
		> 110 VS <90 mmHg	5.61[b,c]	<0.001	2.46[b,c]	<0.001				
Suzuki, 2000	CVD Morbidity and Mortality	Per 10 mmHg		NS		NS	1.67	<0.01	1.71	<0.01

[a] One of three papers from Ohasama study [b] Unadjusted [c] Calculated from data in paper

Evidence Table 48: Prediction of Outcome by pattern of ambulatory blood pressure (white coat hypertension and dipping status) (question #3b)

Study	Outcome	White Coat Hypertension (WCH)				Non-Dipping		
		Definition	Contrast	Estimate (RR)	P-value	Contrast	Estimate (RR)	P-value
Amar, 2000	CVD Mortality					Non Dippers VS Dippers	4.61	0.06
Fagard[a], 2000	CVD Morbidity and Mortality	clinic SBP 160-219 mmHG daytime ABP < 140 mmHG	WCH VS Sustained HTN	0.35[d,e]	0.002			
	Stroke		WCH VS Sustained HTN	0.23[d,e]	0.03			
Nakano, 1999	Dialysis					Reversed Pattern VS Dippers	16.2	<0.05
Ohkubo,[b] 1997a	Total Mortality					Extreme Dipper VS Dippers	0.65	0.29
						Non Dippers VS Dippers	1.35	0.27
						Inverse Dipper VS Dippers	2.12	0.02
	CVD Mortality					Extreme Dipper VS Dippers	0.96	0.95
						Non Dippers VS Dippers	2.56	0.02
						Inverse Dipper VS Dippers	3.69	0.004

Study	Outcome	White Coat Hypertension (WCH)				Non-Dipping		
		Definition	Contrast	Estimate (RR)	P-value	Contrast	Estimate (RR)	P-value
Verdecchia,[c] 1994	CVD Morbidity and Mortality	clinic BP > 140/90 mmHG daytime ABP <131/86 mmHG (women) daytime ABP < 136/87 (men)	Normotensive VS Sustained HTN	0.17[e]		Non Dippers VS Dippers	1.69[e]	
			WCH VS Sustained HTN	0.18[e]				
	CVD Morbidity and Mortality (Men)					Non Dippers VS Dippers	1.04	0.91
	CVD Morbidity and Mortality (Women)					Non Dippers VS Dippers	6.79	0.0002
Verdecchia,[c] 1998	CV Morbidity and Mortality	clinic BP > 140/90 mmHG daytime ABP <131/86 mmHG (women) daytime ABP < 136/87 (men)	WCH VS Sustained HTN	0.3	0.007	Non Dippers VS Dippers	1.46	0.016
Zweiker, 1994	CVD Morbidity and Mortality					Non Dippers VS Dippers	12[d]	0.004
	Total Mortality					Non Dippers VS Dippers	9[d]	0.02

[a] One of two papers from Syst-Eur trial [b] One of three papers from Ohasama study [c] One of the two papers from PIUMA study [d] Unadjusted [e] Calculated from data in paper

Evidence Table 49: Summary of quality characteristics in ambulatory blood pressure measurement trials (question #3d)

Study	Centers	Funding	Adequate Description					Ambulatory BP Trained	Outcome Assessors Blinded	Between Group P-value Reported
			Eligibility	Sample Size Justification	Randomization	BP Therapy	Outcomes			
Schrader, 2000	multi	can't tell	Y	N	Partial	Y	Y	N	N	Y
Staessen, 1997	multi	industry	Y	N	Adequate	Y	Y	N	Y	Y

Evidence Table 50: Summary of population characteristics for ambulatory blood pressure measurement trials (question #3d)

Study	N	Setting	Target Population	Exclusions	Male (%)	Black (%)	Mean Age, years (SD)	HTN (%)	On BP medication (%)
Schrader, 2000	1298	general clinic	age between 34 and 66; normotensives	pregnancy; patients in other study; contraindication to ACE inhibitor	45.7		54.3	0	0
Staessen, 1997	419	general clinic	age >17; hypertensives	pregnancy; chronic renal insufficiency; active CHD/CVD; severe non-cardiac disease; alcohol or psychiatric disorder; hypertensive retinopathy	46.1		52.6	100	0

Evidence Table 51: Summary of methods in ambulatory blood pressure measurement trials (question #3d)

Study	Objective	Duration (months)	Group	N	BP Management Intervention
Schrader, 2000	To determine whether BP guided by ABPM has a better prognosis and requires less medications then BP guided by clinic measurement.	56.4	Control	647	Clinic BP measured at 1,3,9, 12 months and then annually
			ABPM	651	Annual ABP measurement and if office BP > 140/90 [SpaceLabs 90207: Every 15 minutes (day) and every 30 min (night)]
Staessen, 1997	To determine whether BP guided by ABPM would reduce medication use while controlling BP in comparison to BP guided by office measurements.	6.1	Control	206	BP measured at 1, 2, 4, and 6 months
			ABPM	213	ABP measured at 1, 2, 4, and 6 months [SpaceLabs 90207: Every 15 minutes (day) and every 30 min (night)]

Evidence Table 52: Characteristics of outcome measurements in ambulatory blood pressure measurement trials (question #3d)

Study	Measure	Device	Position	Measurements (Number)		
				Per Day	Days	Total
Schrader, 2000	clinic	can't tell	sitting	3	2	6
Staessen, 1997	clinic	can't tell	sitting	3	1	3
	ambulatory	SpaceLabs 90207	NA	NA	1	NA

Evidence Table 53: Effect of ambulatory blood pressure measurement interventions on clinic blood pressure (question #3d)

Study	Group	Systolic Blood Pressure (mmHg)			Diastolic Blood Pressure (mmHg)			Other Findings and Comments
		Baseline Mean (SD)	Change from Baseline in intervention group, net of control		Baseline Mean (SD)	Change from Baseline in intervention group, net of control		
			Change	P-value		Change	P-value	
Schrader, 2000	Control	167.6 (16.9)			99.5 (10)			White coat hypertensives excluded after randomization and replaced with other participants in the ABP group but not in the control group. Fewer CVD events and deaths in ABP vs control BP groups (20 vs 35, P=0.04). Similar rates of hypertension control in ABP and control (59.7% VS 53.4%). Similar use of medications in ABP and control group (31.3% vs 31.7%).
	ABP	165.9 (17.3)	1	NS	100 (10.1)	0	NS	
Staessen, 1997	Control	164.4 (20.3)			104 (9.4)			More ABP patients off of medications (26.3% vs 7.3%, P= <0.001). Fewer ABP patients needed multiple medications (27.2% vs 42.7%, P=<0.001). Change in left ventricular mass was similar in ABP and control group (-2 gm vs -6gm, p=0.56) Total costs (monitoring, medications, and physician fee) were similar in both groups.
	ABP	164.9 (20.3)	3.3	0.06	102.9 (8.9)	1.4	0.16	

Evidence Table 54: Effect of ambulatory blood pressure measurement interventions on 24 Hour, daytime and nighttime ambulatory blood pressure (question #3d)

Study	Group	Systolic Blood Pressure (mmHg)			Diastolic Blood Pressure (mmHg)		
		Baseline Mean (SD)	Change from Baseline in intervention group, net of control		Baseline Mean (SD)	Change from Baseline in intervention group, net of control	
			Change	P-value		Change	P-value
24 Hour ABP							
Staessen, 1997	Control	143.9 (16.3)			89.7 (11.1)		
	ABP	142.5 (15.5)	2.8	0.02	88.5 (10.4)	1.6	0.03
Daytime ABP							
Staessen,1997	Control	150.7 (16.4)			95.6 (11.5)		
	ABP	148.9 (15.9)	2.6	0.04	93.8 (11.1)	1.5	0.06
Nighttime ABP							
Staessen, 1997	Control	131.4 (18.5)			79.1 (12.5)		
	ABP	129.9 (17.1)	3.5	0.01	78.5 (11.8)	1.9	0.03

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Acronyms

ABP	ambulatory blood pressure
AAMI	Association for the Advancement for Medical Instrumentation
BMI	body mass index
BP	blood pressure
BHS	British Hypertension Society
HTN	hypertension
LV	left ventricular
NHBPEP	National High Blood Pressured Education Program
NT	normotension
RR	relative risk
SH	sustained hypertension
SMBP	self-measured blood pressure
WCH	white coat hypertension

Appendix A
Peer Reviewers

In addition to members of the technical advisory group, the partner and individuals within the AHRQ, feedback was received from individuals from the following organizations.

American Academy of Family Physicians
American Academy of Neurology
Association for the Advancement of Medical Instrumentation
American Association of Health Plans
American College of Cardiology
American College of Physicians-American Society of Internal Medicine
American Society of Hypertension
National High Blood Pressure Education Program Coordinating Committee

Appendix B
Journals Searched

Journals Hand Searched

All journals searched January 2001 to May 2001, unless otherwise noted.

Journal Title
American Journal of Hypertension
Annals of Internal Medicine
Archives of Internal Medicine
Blood Pressure Monitoring
Blood Pressure
Blood Pressure Supplementum
British Medical Journal
Circulation
Hypertension
Journal of American Medical Association
Journal of Clinical Hypertension*
Journal of Hypertension
Journal of Hypertension Supplementum
Journal of Human Hypertension
Lancet
New England Journal of Medicine

* Searched from January 1999 to May 2001.

Appendix C
Search Strategies

Search Strategies

PubMed Strategy

("blood pressure monitors"[mh]OR ((monitor*[tw] AND blood pressure[tw]) OR blood pressure measure*[tw]) OR "blood pressure determination"[mh] OR ("monitoring, ambulatory"[mh] AND ("blood pressure"[mh] OR "hypertension"[mh])) AND (self[tw] OR home[tiab] OR ambulatory[tiab] OR portable[tiab] OR 24-h*[tw] OR 24 h*[tw] OR automat*[tiab] OR "white-coat"[tw] OR "white coat"[tw] OR nocturnal[tiab] OR diurnal[tiab] OR circadian[tw] OR dipper[tiab]) AND eng[la] AND journal article[pt] NOT (animal[mh] NOT human[mh])

Cochrane CENTRAL Register of Controlled Trials Strategy

1. BLOOD-PRESSURE-MONITORS*:ME
2. MONITOR*
3. (BLOOD and PRESSURE)
4. (#2 and #3)
5. (BLOOD next (PRESSURE next MEASURE*))
6. BLOOD-PRESSURE-DETERMINATION*:ME
7. BLOOD-PRESSURE-MONITORING-AMBULATORY*:ME
8. BLOOD-PRESSURE*:ME
9. HYPERTENSION*:ME
10. (#8 or #9)
11. (#7 and #10)
12. ((((#1 or #4) or #5) or #6) or #11)
13. SELF
14. HOME
15. AMBULATORY
16. PORTABLE
17. WHITE-COAT
18. (WHITE next COAT)
19. NOCTURNAL
20. DIURNAL
21. CIRCADIAN
22. DIPPER
23. (((((((((#13 or #14) or #15) or #16) or #17) or #18) or #19) or #20) or #21) or #22)
24. (#23 and #12)

HealthSTAR Strategy

blood pressure determination OR blood pressure monitor*

limits: English language, exclude MEDLINE® overlap

Appendix D
Abstract Review Form

<print date> **Utility of BP Measurement Outside of Clinic** **Reviewer: _____**
Abstract Review Form **Data Entry: _____**

<Record #>

<title>

<abstract>

Delete, because article (check one):

☐ does not include ambulatory or self-measurement

☐ does not include human data

☐ not in English

☐ no original data

☐ ≤ 20 patients

☐ meeting abstract (no full article for review)

☐ other: (specify) _____

☐ **Unclear: get article to decide**

Do not go on if any item above is checked.

Study Topics (check all that apply)

☐ **comparison of readings (#1)**

☐ **self-measured and clinical events (#2)**

☐ **ambulatory and clinical events (#3)**

can only select remaining items if article addresses questions 1, 2 or 3:

☐ **subgroups (#4)**

If appropriate, select specific study population:

☐ **pregnant women**

☐ **transplants**

☐ **children (<18 years old)**

☐ This article does not apply to any above study topics.

☐ Article pertains to clinic or standard measurement only

☐ Article pertains to invasive or intra-arterial measurement only

☐ Get article for reference regarding:_____

Any comments to be tagged:_____

<print date> **Utility of BP Measurement Outside of Clinic** **Reviewer: _____**

Second Level Abstract Review Form **Data Entry: _____**

<Record #>

<title>

<abstract>

Delete, because article (check one):

☐ does not include ambulatory or self-measurement

☐ does not include human data

☐ not in English

☐ no original data

☐ meeting abstract (no full article for review)

☐ other: (specify) _____

☐ Unclear: get article to decide

☐ has ≤50 patients or addresses reproducibility and has ≤ 20 patients

☐ describes cross-sectional/retrospective study, addresses only question #2 or #3, and does not include comparison with clinic measurement

☐ describes cross-sectional/retrospective study with outcome other than left ventricular mass or proteinuria/albuminuria

☐ addresses only the prevalence of dipping versus non-dipping and no other research questions

☐ describes clinical trial that does not have longitudinal analysis of clinical outcomes other than blood pressure

☐ does not address any of the research questions

Any comments to be tagged:_____

Appendix E
Quality Assessment Form

Utility of Blood Pressure Monitoring Outside the Clinic Setting
Quality Assessment Form

Article ID#: _____

Reviewer 1: _____

Reviewer 2: _____

Article Eligibility

Article is not eligible for review because (check one):

- F does not include human data
- F not in English
- F no original data
- F meeting abstract (no full article for review)
- F article does not apply to any of the research questions
- F article does not include ambulatory or self-measured blood pressure
- F has ≤30 patients OR addresses reproducibility and has ≤ 20 patients
- F device evaluation was the primary purpose of the study
- F study population is exclusively pregnant women
- F study population is exclusively children (<20 years of age)
- F article addresses research question, but does not present data in an abstractable format. [check appropriate boxes on pages 2-3, then STOP]
- F article addresses only the prevalence of dipping versus non-dipping and no other research questions
- F article describes cross-sectional/retrospective study, addresses only question #2 or #3, and does not include comparison with clinic measurement
- F article describes cross-sectional study, addresses only question #2 or #3, but outcome is not LV mass (by echocardiography) or proteinuria/albuminuria
- F article only addresses question #1, provides data for clinic BP AND ABPM, or clinic BP AND self-BP but does not include a formal within-person comparison of measurements (e.g. no p-value, SE, SD, CI)
- F other. specify: _____

If any item above checked -- STOP.

Focus of Article

Instructions: Identify the focus of the article by checking the appropriate box(es) below. For each box that is checked, refer to the corresponding column(s) to identify the additional sections in Part II of the Article Review Form that need to be completed.

1. Article provides information to address following question(s): [check all that apply]

	Sections To Complete in Part II
#1 Comparison of readings	
? reproducibility of differences and/or patterns (#1 a,b,c)	
? ? distribution of readings between clinic and self-measured blood pressure (#1a)	1,2
? ? distribution of readings between clinic and ambulatory blood pressure measurements (#1a)	1,2
? ? distribution of readings between self-measured and ambulatory blood pressure measurements (#1a)	1,2
? ? prevalence of white-coat hypertension defined by self-measurement devices (#1b)	1
? ? prevalence of white-coat hypertension defined by ambulatory measurement devices (#1c)	1
#2 Self-measured blood pressure and clinical events	
? Self-measured blood pressure associated with LV mass (#2a)	
? ? mean BP levels (#2a)	1,3
? ? white-coat hypertension (#2a)	1,3
? ? incremental gain (#2c)	
Self-measured blood pressure associated with proteinuria/albuminuria (#2a)	
? ? mean BP levels (#2a)	1,4
? ? white-coat hypertension (#2a)	1,4
? ? incremental gain (#2c)	
? ? Prediction of clinical outcomes [longitudinal study] (#2b)	
? ? Effect of treatment guided by self-measured blood pressure (#2d)	
#3 Ambulatory blood pressure and clinical events	
Ambulatory blood pressure associated with LV mass (#3a)	
? ? mean BP levels (#3a)	1,3
? ? white-coat hypertension (#3a)	1,3
? ? dippers (TBD)	
? ? incremental gain (#3c)	

	Sections To Complete in Part II
Ambulatory blood pressure associated with proteinuria/albuminuria (#3a)	
? ? mean BP levels (#3a)	1,4
? ? white-coat hypertension (#3a)	1,4
? ? dippers (TBD)	
? ? incremental gain (#3c)	
? ? ? Prediction of clinical outcomes [longitudinal study] (#3b)	
? ? ? Effect of treatment guided by ambulatory blood pressure (#3d)	
#4 Does evidence for any of the above questions vary by subgroups	
? comparison of readings (#1)	
? ? self-measured and clinical events (#2)	
? ? ambulatory and clinical events (#3)	
Study addresses the following population(s) of interest:	
? age	Part II
? sex	Part II
? race	Part II
? diabetes	Part II
? dialysis	Part II
? renal transplant patients	Part II
? hypertensives	Part II
? normotensives	Part II
? white-coat hypertensives	
? sustained hypertensives	
? excess variability	Part II
? anti-hypertensive medications	Part II
? chronic renal insufficiency	Part II
? proteinuria/albuminuria	Part II
? active or prior cardiac or cerebrovascular disease	Part II
? current smoking	Part II
? obese individuals	Part II
? drug resistant hypertension	Part II
? autonomic dysfunction	Part II
? other: _____	
? other: _____	
? other: _____	

If not directed to a section in Part II- STOP

If directed to a section(s) in Part II- complete page 4 and 5 of this form, then complete Part I followed by Part II

Quality Assessment Questions:

1) Type of study:

O single center
O multi center
O can't tell

2) Source(s) of funding:

? device manufacturer
? other industry
? government
? organization other than government or industry
O can't tell or not stated

3) Were the inclusion and exclusion criteria adequately reported?

O yes, sufficient to replicate study design
O no

4) Were recruitment procedures adequately described?

O yes, sufficient to replicate study design
O no

5) Does the study provide basic characteristics of participants (age, gender, % on HTN medication)?

O yes, all 3 items reported
O no, one or more items missing
O not applicable

6) Were the individuals who collected office/clinic BP masked (blinded) to other relevant data (e.g. ambulatory measurements, self-measurements or clinical outcomes)?

O yes, explicitly stated OR clinic BP measurements completed prior to other measurements (masking accomplished by study design)
O no, or not reported

7) For studies with LV mass or clinical outcomes, were the assessors of these outcomes masked (blinded) to blood pressure data? (eg echo technicians)

O yes, explicitly stated or implicit in design
O no, or not reported
O not applicable

8) For prospective studies, how complete were the follow-up data?

O $\geq$ 80% of data on enrolled participants
O < 80% of data on enrolled participants
O can't tell or not stated
O not applicable

9) For the primary analyses, were both the magnitude of differences or association AND an index of variability (e.g. test statistic, p value, standard error, confidence interval) stated?

O yes, both reported
O no, one or both not reported

10) For observational studies, were the adjustment procedures appropriate?

O yes
O no
O not applicable

11) Was the analytic approach appropriate?

O yes
O no

Comments:

Utility of Blood Pressure Monitoring Outside the Clinic Setting
PART I

Article ID#: _____

Reviewer 1: _____

Reviewer 2: _____

General Study Characteristics

1 The analysis of interest was of the following design:

F randomized controlled trial
F non-randomized controlled trial
F cohort study
F case-control
F cross-sectional
F before-after
F case series
F can't tell or not stated

2. Study was completed in:

F United States
F Canada
F United Kingdom
F Can't tell or not stated
F Other. Specify: _____

3. Setting. Study population was drawn from (check all that apply):

G general clinic
G specialty hypertension clinic
G other specialty clinic
G general population
G other research study unspecified
G other. specify: _____
F can't tell or not stated

Clinic Blood Pressure Measurement

4. Who was the observer for blood pressure measurements?

□ medical technician
□ nurse
□ physician assistant
□ physician
□ student
□ can't tell or not stated
□ other. specify: _____

Note: If data are provided separately for multiple observers, use data for the observer closest to the top of above list (eg use nurse data if both nurse and physician data are provided).

5. Did the results of the study differ according to type of observer?

O yes
O no
O not applicable

6. Was the observer trained?

F yes
F no
F can't tell or not stated

7. What type of blood pressure measurement device was used?

F mercury
F mercury random zero
F aneroid
F automated
F multiple devices, GO TO Question 9, page 4
F can't tell or not stated

8. If automated, indicate the device number from list of validated devices: _____

1.	CAS Model 9010
2.	Datascope Accurtorr Plus

if device is not on list, provide following information:

name and model: _____

O can't tell or not stated
O not applicable

9. If manual, indicate Korotkoff sound used for diastolic blood pressure:

O K4
O K5
O can't tell or not stated
O not applicable

10. Did the study use or adapt a standard technique, such as that provided by a professional society (e.g., AHA) or a major study (e.g., HDFP)

O yes
O no. If no, did the study specify that they utilized:
    □ appropriate cuff size
    □ wait of at least 2 minutes before obtaining measurements
    O can't tell or not stated
O can't tell or not stated

11. What was the position of the participant?

O supine
O standing
O sitting
O combination
O can't tell or not stated

12. What was the planned number of clinic BP measurements?

_____ measurements per day for _____ days

O other: _____
O can't tell or not stated

13. Actual number of days blood pressure measured (complete all available):

mean: _____

median: _____

range: _____ to _____

O can't tell or not stated

14. Actual number of blood pressure readings per day (complete all available):

mean: _____

median:_____

range _____ to _____

O can't tell or not stated

15. Actual total number of blood pressure readings (complete all available):
[if total is not provided, calculate when possible: total= number of days measured times number of readings per day]

mean: _____

median: _____

range: _____

O calculated by reviewer
O can't tell or not stated

Comments- Clinic BP:

Self Blood Pressure Measurement

16. Was self blood pressure measured?

O yes
O no, **STOP and GO TO Question 29, page 9**

17. The blood pressure measurements were taken by:

□ patient
□ someone else
O can't tell or not stated

18. Was the observer trained?

O yes
O no
O can't tell or not stated

19. What type of blood pressure measurement device was used?

O mercury
O aneroid
O electronic or automated
O can't tell or not stated

20. If automated, indicate the device number from list of validated devices: _____

1	Omron HEM-705CP
2	Omron HEM-722C
3	Omron HEM-735C
4	Omron HEM-713C
5	Omron HEM-737 Intellisense

if device is not on list, provide following information:

name and model: _____

O can't tell or not stated
O not applicable

21. If auscultatory, indicate Korotkoff sound used for diastolic blood pressure:

O K4
O K5
O can't tell or not stated
O not applicable

22. How were the measurements recorded?

O patient/observer recorded
O stored electronically
O can't tell or not stated

23. What were the times of recordings?

□ morning (before noon)
□ afternoon (noon to 6:00pm)
□ evening (after 6:00pm)
O can't tell or not stated

24. Where were the measurements recorded?

□ work
□ home
O can't tell or not stated

25. What was the planned number of self-BP measurements?

_____ measurements per day for _____ days

O other: _____
O can't tell or not stated

26. Actual number of days blood pressure measured (complete all available):

mean: _____

median: _____

range: _____

O can't tell or not stated

27. Actual number of blood pressure readings per day (complete all available):

mean: _____

median:_____

range: _____

O can't tell or not stated

28. Actual total number of blood pressure readings (complete all available)
[if total is not provided, calculate when possible: total= number of days measured times number of readings per day]:

mean: _____

median: _____

range: _____

O calculated by reviewer

O can't tell or not stated

Comments- Home BP:

Ambulatory Blood Pressure Measurement

29. Was ambulatory blood pressure measured?

O yes
O no, **STOP and GO TO question 43, page 12**

30. Was the patient given instructions?

O yes (eg keep arm still and/or stop movement during measurements)
O no
O can't tell or not stated

31. What type of blood pressure measurement device was used?

O auscultatory
O oscillometric
O both (if both, use auscultatory to answer all subsequent questions)
O can't tell or not stated

32. Indicate the device number from list of devices: _____

1	CH-DRUCK	9	Schiller BR-102	17	Accutracker II
2	Daypress 500	10	SpaceLabs 90202	18	DIASYS 200
3	DIASYS Integra	11	SpaceLabs 90207	19	Medilog ABP
4	ES-H531	12	SpaceLabs 90217	20	Nissei DS-240
5	Meditech ABPM-04	13	Takeda 2430	21	OSCILL-IT
6	Profilomat	14	TM-2420, model 7	22	Profilomat II
7	QuietTrak	15	TM-2420,model 6	23	Takeda 2421
8	Save 33, model 2	16	TM-2421	24	TM-2420, model 5

If device is not on list, provide following information:
name and model: _____
O can't tell or not stated

33. Were the presented measurements edited?

O yes
O no
O can't tell or not stated

34. How were measurements edited?

G device
G during analysis
O can't tell or not stated

35. Where were the measurements taken?

G Work (work day)
G Home (non-work day)
O can't tell or not stated

36. Duration of measurement?

O awake or day time only
O 24 hour recording period
O >24 hours (or more than 1 recording period)
O can't tell or not stated

37. How did the study define daytime/awake and nighttime/asleep?

Awake or daytime:

Indicate period of measurement:

O awake hours as reported by patient
O daytime defined by:

start time: _____
O am O pm

end time: _____
O am O pm

O can't tell or not stated

Asleep or nighttime

Indicate period of measurement:

O asleep hours as reported by patient
O nighttime defined by:

start time: _____
O am O pm

end time: _____
O am O pm

O can't tell or not stated

38. What was the time interval on the monitor between measurements during daytime/awake hours?

O 1 reading every _____ minutes
O not applicable
O can't tell or not stated

39. What was time interval on the monitor between measurements during nighttime/sleep hours?

O 1 reading every _____ minutes
O not applicable
O can't tell or not stated

40. Actual number of daytime blood pressure readings per 24-hour period (complete all available):

mean: _____

median: _____

range: _____

O not applicable
O can't tell or not stated

41. Actual number of nighttime blood pressure readings per 24-hour period (complete all available):

mean: _____

median: _____

range: _____

O not applicable
O can't tell or not stated

42. Total number of blood pressure readings per 24-hour period (including day and night, complete all available):

mean: _____

median: _____

range: _____

O calculated by reviewer
O can't tell or not stated

Comments-Ambulatory BP:

Definitions of hypertension

43. How was hypertension defined?

O Definition of hypertension not applicable for this study

? Cut-off values for HT – Clinic BP
SBP: ≥ _____(mmHg)
DBP: ≥ _____(mmHg)

? Cut-off values for HT – Self-BP
SBP: ≥ _____(mmHg)
DBP: ≥ _____(mmHg)

? Cut-off values for HT – ABPM
SBP: ≥ _____(mmHg)
O Based on Daytime BP
O Based on 24-Hour BP

DBP: ≥ _____(mmHg)
O Based on Daytime BP
O Based on 24-Hour BP

44. How was white coat-hypertension defined?

O not applicable for this study
O cross-tabulation of clinic BP and self-BP
O cross-tabulation of clinic BP and ABPM
O other method:_____
O applicable for this study, but definition not stated

Echocardiographic Assessment of LV mass

45. What type of echocardiograph was used to assess LV mass?

O not applicable for this study- **STOP and go to Question 51**
O M-mode (with or without Doppler)
O Other – Specify: _____
O Unknown

46. Number of cycles averaged to assess LV mass: _____ O Unknown

47. Use of Penn convention for measurement:

O yes
O no
O unknown

48. Method used to estimate LV mass:

O Devereaux
O Other – Specify: _____
O Unknown

49. Units for LV mass index:

O LV mass by surface area (g/m^2)
O LV mass by height (g/m)
O LV mass by height^2 (g/m^2)
O LV mass by height$^{2.7}$ ($g/m^{2.7}$)
O LV mass (g)
O Other – Specify: _____
O Unknown

50. Cut-off value for LV hypertrophy:

O males: _____
O females: _____
O unknown
O not applicable

Assessment of Urine Protein/Albumin

51. Measures of protein excretion?

O not applicable for this study
O mg of protein/ 24 hours
O mg of protein/ mg creatinine
O not measured

52. Measures of albuminuria?

O not applicable for this study
O mg of albumin/ 24 hours
O mg of albumin/ mg creatinine
O not measured

53. Cut-off values for proteinuria?

O not applicable for this study
O males: _____
O females: _____

54. Cut-off values for microalbuminuria?

O not applicable for this study
O males: _____
O females: _____

55. Type of urine collection?

O not applicable for this study
O 24-Hour
O spot
O timed collection for _____ hours
O can't tell or not stated

Formal Comparison of BP readings

56. What was the order of measurement for the comparison of clinic BP and self BP?

O not applicable for this study
O clinic BP measured first
O self BP measured first
O random order of measurement
O non-random order
O other, including multiple
O can't tell or not specified

57. What was the order of measurement for the comparison of clinic BP and ABPM?

O not applicable for this study
O clinic BP measured first
O daytime BP measured first
O random order of measurement
O non-random order
O other, including multiple
O can't tell or not specified

58. What was the order of measurement for the comparison of self BP and ABPM?

O not applicable for this study
O self BP measured first
O nighttime BP measured first
O random order of measurement
O non-random order
O other, including multiple
O can't tell or not specified

Patient Characteristics

59. Complete the following information for the **entire study population**. (Record data as it is presented- N or % or both. If only subgroup data is provided, calculate data for the entire study population when possible.)

	N	%
Number of Patients		
Males		
African-American		
Asian		
White		
Other race		
Diabetics		
On BP medication		
On dialysis		
Active or prior cardiac or cerebrovascular disease		
Current Smokers		
Hypertension- defined by clinic BP		
Hypertension-defined by self BP		
Hypertension- defined by ABPM		
Normotension- Normal clinic BP and normal self BP		
Normotension-Normal clinic BP and normal ABPM		
White-coat HTN (high clinic but normal self BP)		
White-coat HTN (high clinic but normal ABPM)		
Sustained HTN (high clinic and high self)		
Sustained HTN (high clinic and high ABPM)		

60. Please indicate the exclusion criteria, as well as, if appropriate, the specific population(s) included in the study. [Check all that apply]

Exclusion Criteria	Specific Population Targeted	Criteria
G	G	Age <_____ years
G	G	Age > _____ years
G	G	Males
G	G	Females
G	G	One or more racial or ethnic groups
G	G	Pregnancy
G	G	Hypertensives
G	G	Normotensives
G	G	Anti-hypertensive medication
G	G	Diabetes
G	G	Dialysis
G	G	Chronic renal insufficiency (not on dialysis)
G	G	Renal transplant patients
G	G	Proteinuria/albuminuria
G	G	Excess variability
G	G	Active or prior cardiac or cerebrovascular disease
G	G	Current smoking
G	G	Obese individuals
G	G	Drug resistant hypertension
G	G	Autonomic dysfunction
G	G	Other: _____
G	G	Other: _____
O	Exclusion criteria not stated or can't tell	
	O	no specific population

61. Summarize in one sentence the main aim of this study.

62. Summarize in one or two sentences the main finding(s) of this study that is/are relevant to any of our research questions

63. General Comments:

64. Provide number of people for which each of the following completed:

Clinic BP _____ O not applicable

Self BP _____ O not applicable

AMBP _____ O not applicable

Echocardiograph _____ O not applicable

Urine protein/albuminuria _____ O not applicable

65. Study included results presented as:

G one group or whole group
G subgroups.

If subgroups, specify the number abstracted in Part II (see page 3, Quality Assessment Form)

Number of subgroups: _____

Provide names for each subgroup to be abstracted in Part II (see page 3, Quality Assessment Form)

	Name
Group A	
Group B	
Group C	
Group D	
Group E	

Utility of Blood Pressure Monitoring Outside the Clinic Setting

PART II- RESULTS

Article ID#: _____

Reviewer 1: _____

Reviewer 2: _____

Complete and submit separate results sections for each required group (refer to page 3 of the Quality Assessment Form) and for the entire study population. Results on this form completed for (circle one):
Whole Group Group A Group B Group C Group D Group E

OUTLINE

SECTION 1
PATIENT DEMOGRAPHICS

1. Complete the following information for each required group (this question should NOT be completed for the entire study population). Record data only as it is presented-N or % or both.

	N	%
Number of Patients		
Males		
African-American		
Asian		
White		
Other race		
Diabetics		
On BP medication		
On dialysis		
Active or prior cardiac or cerebrovascular disease		
Current Smokers		
Hypertension- defined by clinic BP		
Hypertension-defined by self BP		
Hypertension- defined by ABPM		
Normotension- Normal clinic BP and normal self BP		
Normotension-Normal clinic BP and normal ABPM		
White-coat HTN (high clinic but normal self BP)		
White-coat HTN (high clinic but normal ABPM)		
Sustained HTN (high clinic and high self BP)		
Sustained HTN (high clinic and high ABPM)		

2. Complete the following table:
   - only record other data if mean and SD are **NOT** provided
   - if clinic BP data are provided for various positions, only record **sitting BP**

	Mean	**SD**	Median	Range	SE	upper 95% CI	lower 95% CI
Age							
Clinic SBP							
Clinic DBP							
Self SBP							
Self DBP							
Day SBP							
Day DBP							
Night SBP							
Night DBP							
24-hour SBP							
24-hour DBP							
Δ Day-night SBP							
Δ Day-night DBP							

SECTION 2
COMPARISON OF CLINIC, SELF AND AMBULATORY BLOOD PRESSURE MEASUREMENTS

If study does not compare BP measurements, **STOP and GO TO Question 26, page 14**

3. Does study address distribution of readings between **CLINIC BP** and **SELF-MEASURED BP**?

O Yes
O No**, STOP and go to Question 6, page 5**

SECTION 2.1
FORMAL COMPARISON OF SELF-MEASURED BP AND CLINIC BP

(Distribution of readings between clinic and self-measured blood pressure-#1a)

For each study that reports the blood pressure difference between CLINIC BP and SELF BP indicate the following information:

4. BP Difference (difference is defined as **clinic BP** minus **self BP**):

	SBP Difference	**DBP Difference**
Mean (Difference)		
SD (Difference)		
SE (Difference)		
95%CI (Difference)	to	to
Range (Difference)	to	to
P-Value (Difference)		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

5. Correlation Coefficient for **Clinic BP** and **Self BP**:

	SBP	**DBP**
Estimate		
SE		
95%CI	to	to
P-Value		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

SECTION 2.2
COMPARISON OF ABPM AND CLINIC BP

Distribution of readings between clinic and ambulatory blood pressure (#1a)

6. Does the study address distribution of readings between **CLINIC BP** and **ABPM?**

O Yes

O No, **STOP and GO TO question 16, page 8**

7. Does the study address distribution of readings between **CLINIC BP** and **DAYTIME BP** measurements (#1a)?

O Yes

O No, **STOP and GO TO question 10, page 6**

For each study that reports the blood pressure difference between **CLINIC BP** and **DAYTIME BP** indicate the following information:

8. BP Difference (difference is defined as **clinic BP** minus **daytime BP**)

	SBP Difference	**DBP Difference**
Mean (Difference)		
SD (Difference)		
SE (Difference)		
95%CI (Difference)	to	to
Range (Difference)	to	to
P-Value (Difference)		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

9. Correlation Coefficient for **Clinic BP and Daytime BP**

	SBP	**DBP**
Estimate		
SE		
95%CI	to	to
P-Value		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

10. Does the study address distribution of readings between **CLINIC BP** and **NIGHTTIME BP** blood pressure measurements?

O Yes
O No, **STOP and go to question 13, page 7**

For each study that reports the blood pressure difference between **CLINIC BP** and **NIGHTTIME BP** indicate the following information:

11. BP Difference (difference is defined as **clinic BP** minus **nighttime BP**)

	SBP Difference	**DBP Difference**
Mean (Difference)		
SD (Difference)		
SE (Difference)		
95%CI (Difference)	to	to
Range (Difference)	to	to
P-Value (Difference)		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

12. Correlation Coefficient for **Clinic BP** and **Nighttime BP**

	SBP	**DBP**
Estimate		
SE		
95%CI	to	to
P-Value		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

13. Does the study address the blood pressure difference between **CLINIC BP** and **24-HOUR BP**?

O Yes

O No, **STOP and GO TO Question 16, page 8**

For each study that reports the blood pressure difference between **CLINIC BP** and **24 HOUR BP** indicate the following information:

14. BP Difference (difference is defined as **clinic BP** minus **24-Hour BP**)

	SBP Difference	**DBP Difference**
Mean (Difference)		
SD (Difference)		
SE (Difference)		
95% CI (Difference)	to	to
Range (Difference)	to	to
P-Value (Difference)		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

15. Correlation Coefficient for **Clinic BP** and **24-Hour BP**

	SBP	DBP
Estimate		
SE		
95% CI	to	to
P-Value		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

SECTION 2.3
COMPARISON OF ABPM AND SELF BP

Distribution of readings between ABPM and self-BP (#1a)

16. Does the study address distribution of readings between **SELF BP** and **ABPM?**

O Yes

O No, **STOP and GO TO question 26, page 11**

17. Does the study address distribution of readings between **SELF BP** and **DAYTIME BP** measurements (#1a)?

O Yes

O No, **STOP and GO TO question 20, page 9**

For each study that reports the blood pressure difference between **SELF BP** and **DAYTIME BP** indicate the following information:

18. BP Difference (difference is defined as **self BP** minus **daytime BP**)

	SBP Difference	**DBP Difference**
Mean (Difference)		
SD (Difference)		
SE (Difference)		
95%CI (Difference)	to	to
Range (Difference)	to	to
P-Value (Difference)		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

19. Correlation Coefficient for **Self BP and Daytime BP**

	SBP	**DBP**
Estimate		
SE		
95%CI	to	to
P-Value		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

20. Does the study address distribution of readings between **SELF BP** and **NIGHTTIME BP** blood pressure measurements?

O Yes
O No, **STOP and go to question 23, page 10**

For each study that reports the blood pressure difference between **SELF BP** and **NIGHTTIME BP** indicate the following information:

21. BP Difference (difference is defined as **self BP** minus **nighttime BP**)

	SBP Difference	**DBP Difference**
Mean (Difference)		
SD (Difference)		
SE (Difference)		
95%CI (Difference)	to	to
Range (Difference)	to	to
P-Value (Difference)		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

22. Correlation Coefficient for **Self BP** and **Nighttime BP**

	SBP	**DBP**
Estimate		
SE		
95%CI	to	to
P-Value		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

23. Does the study address the blood pressure difference between **SELF BP** and **24-HOUR BP**?

O Yes

O No, **STOP and GO TO Question 26, page 11**

For each study that reports the blood pressure difference between **SELF BP** and **24 HOUR BP** indicate the following information:

24. BP Difference (difference is defined as **self BP** minus **24-Hour BP**)

	SBP Difference	**DBP Difference**
Mean (Difference)		
SD (Difference)		
SE (Difference)		
95%CI (Difference)	to	to
Range (Difference)	to	to
P-Value (Difference)		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

25. Correlation Coefficient for **Self BP** and **24-Hour BP**

	SBP	DBP
Estimate		
SE		
95% CI	to	to
P-Value		
	O p>0.05	O p>0.05
	O p<0.05	O p<0.05
	O p<0.01	O p<0.01
	O p<0.001	O p<0.001

SECTION 3
LV MASS AND BP

26. Does the paper address the association between LV mass and ambulatory BP and/or self-measured BP AND provide a comparison with clinic BP?

O Yes
O No, **STOP and GO TO Question 69, page 29**

27. Is LV mass measured by echocardiogram?

O Yes
O No, **STOP and GO TO Question 69, page 29**

28. LV mass index:

? mean: _____
? SD: _____
? SE: _____
? median: _____
? IQR: _____ to _____
? 95% CI: _____ to _____
? Range: _____ to _____
O Unknown

29. Proportion of patients with LV hypertrophy _____ (%) O Unknown

SECTION 3.1
CLINIC BP AND LV MASS: CROSS-SECTIONAL STUDIES

(Question #2a and Question #3a)

Instructions: In the following sections, a paper may present the same association with different degrees of adjustment. Please, abstract always the **maximally adjusted model** (EXCEPT if separate subgroups are being reported – in this case, abstract the **subgroup specific data** rather than the overall model).

30. **Clinic BP and LV mass**:

	Correlation Coefficient **Clinic SBP** and LV mass	Correlation Coefficient **Clinic DBP** and LV mass	Variance Explained (R^2) **Clinic SBP** and LV mass	Variance Explained (R^2) **Clinic DBP** and LV mass	Regression Coefficient **Clinic SBP** and LV mass	Regression Coefficient **Clinic DBP** and LV mass
Estimate:						
SE						
95% CI:	to	to	to	to	to	to
P value:	_____	_____	_____	_____	_____	_____
	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001

31. **Clinic BP and LV mass**:

	Correlation Coefficient	Variance Explained (R^2)	Regression Coefficient
Type of coefficient:			
Pearson (Parametric)	O	O	O
Spearman (Non-Parametric)	O	O	O
Unknown	O	O	O
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
ABPM	**G**	**G**	**G**
SELF BP	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, restricted etc.):			
None	O	O	O
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O

SECTION 3.2

SELF BP AND LV MASS: CROSS-SECTIONAL STUDIES

Self-measured BP and association with blood pressure-related target organ damage (Question #2a)

32. Does study address self-measured BP and LV mass?

O Yes

O No, **STOP and GO TO Question 49, page 21**

33. **Self BP and LV mass**:

	Correlation Coefficient **Self SBP** and LV mass	Correlation Coefficient **Self DBP** and LV mass	Variance Explained (R^2) **Self SBP** and LV mass	Variance Explained (R^2) **Self DBP** and LV mass	Regression Coefficient **Self SBP** and LV mass	Regression Coefficient **Self DBP** and LV mass
Estimate:						
SE						
95% CI:	to	to	to	to	to	to
P value:	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001

34. **Self BP and LV mass**:

	Correlation Coefficient	Variance Explained (R^2)	Regression Coefficient
Type of coefficient:			
Pearson (Parametric)	O	O	O
Spearman (Non-Parametric)	O	O	O
Unknown	O	O	O
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Clinic BP	**G**	**G**	**G**
ABPM	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, restricted etc.):			
None	O	O	O
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O

35. Did this study address the incremental gain in prediction of LV mass from self measurement devices beyond prediction from clinic BP alone? (e.g. are both variables in the same model?)

O Yes
O No
O Can't tell or not stated

CROSS SECTIONAL COMPARISON OF LV MASS IN NORMOTENSIVES, WHITE-COAT HYPERTENSIVES AND SUSTAINED HYPERTENSIVES- SELF BP

(Question #2a)

36. Does the study compare LV mass in normotensives, white-coat hypertensives and/or sustained hypertensives, assessed by SELF BP?

O Yes

O No, **STOP and GO TO Question 49, page 21**

BLOOD PRESSURE BY CATEGORY OF HYPERTENSION-BASED ON SELF BP

Instructions:

- Only record other data if mean and SD are NOT provided
- If clinic BP is provided for various positions- record only **sitting BP**

37. Blood pressure in clinic and self normotensives:

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							

38. For clinic and self normotensives, indicate the following additional information:

Males: N_____ (%) _____

Race:

African-American: N_____ (%) _____

Asian N_____ (%) _____

White N_____ (%) _____

Other N_____ (%) _____

Mean Age: _____

39. **Blood pressure in white-coat hypertensives (Self BP)**

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							

40. For self-BP white-coat hypertensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

41. **Blood pressure in Self BP sustained**

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							

42. For clinic and Self BP sustained hypertensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

LV MASS INDEX BY CATEGORY OF HYPERTENSION- BASED ON SELF BP

43. Complete the following table for LV Mass by category of hypertension:
– Only record other measurements if mean and SD are NOT provided

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic & SELF BP Normotensive	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP White-coat Hypertensive	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP sustained Hypertensive	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							

44. Proportion of clinic & Self BP normotensives with LV hypertrophy:
_____(%) O Can't tell or not stated

45. Proportion of Self BP white-coat hypertensives with LV hypertrophy:
_____(%) O Can't tell or not stated

46. Proportion of Self BP sustained hypertensives with LV hypertrophy:
__ ____(%) O Can't tell or not stated

DIFFERENCE IN LV MASS BY CATEGORY OF HYPERTENSION-BASED ON SELF-BP

If study does not address difference in LV mass**, STOP and GO TO Question 49, page 21**

47. Complete the following table:

	White-coat hypertensives minus normotensives (Self BP)	Sustained hypertensives minus normotensives (Self BP)	Sustained hypertensives minus white-coat hypertensives (Self BP)
Estimate:	_____	_____	_____
SE:	_____	_____	_____
95% CI:	_____to_____	_____to_____	_____to_____
P value:	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001
Adjustment:			
Unadjusted, Crude	O	O	O
Adjusted for:			
Clinic BP	O	O	O
Other, Specify:	_____	_____	_____
Other, Specify	_____	_____	_____

48. Complete the following table for the OR of LV hypertrophy by category of hypertension, assessed by Self BP:

	White-coat hypertensives vs. normotensive (Self BP)	Sustained hypertensives vs. normotensives (Self BP)	Sustained hypertensives vs. white-coat hypertensives (Self BP)
OR:			
95% CI:	_____ to_____	_____to_____	_____to_____
P value:	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Clinic BP	**G**	**G**	**G**
Other, Specify	_____	_____	_____
Other, Specify	_____	_____	_____
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, etc.):			
None	O	O	
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other, Specify	_____	_____	_____
Other, Specify	_____	_____	_____
Unknown	O	O	O

Comments: Self BP and LV Mass

SECTION 3.3
AMBULATORY BP AND LV MASS: CROSS-SECTIONAL STUDIES

(ABPM and association with blood pressure-related target organ damage- #3a)

49. Does study address the association between ABPM and LV mass?

O Yes

O No, **STOP and GO TO Question 69, page 29**

50. **24-Hour BP and LV mass:**

	Correlation Coefficient **24-Hour SBP** and LV mass	Correlation Coefficient **24-Hour DBP** and LV mass	Variance Explained (R^2) **24-Hour SBP** and LV mass	Variance Explained (R^2) **24-Hour DBP** and LV mass	Regression Coefficient **24-Hour SBP** and LV mass	Regression Coefficient **24-Hour DBP** and LV mass
Estimate:						
SE:						
95% CI:	to	to	to	to	to	to
P value	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001

51. **Daytime BP and LV mass:**

	Correlation Coefficient **Day SBP** and LV mass	Correlation Coefficient **Day DBP** And LV mass	Variance Explained (R^2) **Day SBP** and LV mass	Variance Explained (R^2) **Day DBP** and LV mass	Regression Coefficient **Day SBP** and LV mass	Regression Coefficient **Day DBP** and LV mass
Estimate:						
SE:						
95% CI:	to	to	to	to	to	to
P value	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001

52. **Nighttime BP and LV mass index:**

	Correlation Coefficient **Night SBP** and LV mass	Correlation Coefficient **Night DBP** and LV mass	Variance Explained (R^2) **Night SBP** and LV mass	Variance Explained (R^2) **Night DBP** and LV mass	Regression Coefficient **Night SBP** and LV mass	Regression Coefficient **Night DBP** and LV mass
Estimate:						
SE:						
95% CI:	to	to	to	to	to	to
P value	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001

53**.** **ABPM and LV mass index:**

	Correlation Coefficient	Variance Explained (R^2)	Regression Coefficient
Type of coefficient:			
Pearson (Parametric)	O	O	O
Spearman (Non-Parametric)	O	O	O
Unknown	O	O	O
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Clinic BP	**G**	**G**	**G**
Self-measured BP	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, restricted etc.):			
None	O	O	O
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O

54. Did this study address the incremental gain in prediction of LV mass from ambulatory devices beyond prediction from clinic BP alone? (e.g. are both variables in the same model?)

O Yes
O No
O Can't tell or not stated

CROSS-SECTIONAL COMPARISON OF LV MASS IN NORMOTENSIVES, WHITE-COAT HYPERTENSIVES AND SUSTAINED HYPERTENSIVES-ABPM
(Question #2a)

55. Does the study compare LV mass in normotensives, white-coat hypertensives and/or sustained hypertensives, assessed by ABPM?

O Yes

O No, **STOP and GO TO Question 69, page 29**

BLOOD PRESSURE BY CATEGORY OF HYPERTENSION

Instuctions:

- Only record other measurements if mean and SD are NOT provided
- If BP pressure data are provided for various positions- use only sitting BP

56. **Blood pressure in clinic and ABPM normotensives**:

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
24-Hour SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
24-Hour DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Day SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Day DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Night SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Night DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							

57. For clinic and ABPM normotensives, indicate the following additional information:

Males: N_____ (%) _____

Race:

African-American: N_____ (%) _____

Asian N_____ (%) _____

White N_____ (%) _____

Other N_____ (%) _____

Mean Age: _____

58. **Blood pressure in ABPM white-coat hypertensives**

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
24-Hour SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
24-Hour DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Day SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Day DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Night SBP	_____	_____	_____	_____	_____to_____	_____to___	____to____
O No Information Provided							
Night DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							

59. For ABPM white-coat hypertensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

60. **Blood pressure in ABPM sustained hype rtensives**

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
24-Hour SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
24-Hour DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Day SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Day DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Night SBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
Night DBP	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							

61. For ABPM sustained hypertensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

LV MASS BY CATEGORY OF HYPERTENSION BASED ON ABPM

(Question #3a)

62. Complete the following table for the mean LV mass index by category of hypertension:
- Only report other variables if Mean and SD are NOT provided

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic & ABPM normotensives	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
ABPM White-coat Hypertensives	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							
ABPM Sustained Hypertensives	_____	_____	_____	_____	_____to_____	_____to____	____to____
O No Information Provided							

63. Proportion of clinic & ABPM normotensives with LV hypertrophy:
_____(%) O Unknown

64. Proportion of ABPM white-coat hypertensives with LV hypertrophy
_____(%) O Unknown

65. Proportion of ABPM sustained hypertensives with LV hypertrophy:
_____(%) O Can't tell or not stated

DIFFERENCE IN LV MASS BY CATEGORY OF HYPERTENSION- BASED ON ABPM

If study does not address difference in LV mass, **STOP** and **GO TO Question 69 page 29**

66. Complete the following table for the difference in LV by category of hypertension:

	White-coat hypertensives minus normotensives (ABPM)	Sustained hypertensives minus normotensives (ABPM)	Sustained hypertensives minus white-coat hypertensives (ABPM)
Estimate:			
SE:			
95% CI:	_____to_____	_____to_____	_____to_____
P value:	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001
Adjustment:			
Unadjusted, Crude	O	O	O
Adjusted for:			
Clinic BP	O	O	O
Other, Specify:	_____	_____	_____
Other, Specify	_____	_____	_____

ODDS RATIOS OF LV HYPERTROPHY IN NORMOTENSIVES, WHITE-COAT HYPERTENSIVES AND SUSTAINED HYPERTENSIVES- ABPM

67. Does the study present the OR of LV hypertrophy in normotensives, white-coat hypertensives or sustained hypertensives, assessed by ABPM?

O Yes

O No, **STOP and GO TO Question 69, page 29**

68. Complete the following table for the OR of LV hypertrophy by category of hypertension assessed by ABPM

	White-coat hypertensives vs. normotensives (ABPM)	Sustained hypertensives vs. normotensives (ABPM)	Sustained Hypertensives vs. white-coat hypertensives (ABPM)
OR:			
95% CI:	_____to_____	_____to_____	_____to_____
P value:	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Clinic BP	**G**	**G**	**G**
Other, Specify	_____	_____	_____
Other, Specify	_____	_____	_____
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, etc.):			
None	O	O	
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other, Specify	_____	_____	_____
Other, Specify	_____	_____	_____
Unknown	O	O	O

Comments: ABPM and LV mass

SECTION 4
URINE PROTEIN AND BP

BP and association with blood pressure-related target organ damage (#2)

69. Does the paper address the association between urine protein and self-BP and/or ABPM AND provide a comparison with clinic BP?

O Yes
O No, **STOP**- this form is complete

SECTION 4.1
CLINIC BP AND URINE PROTEIN: CROSS-SECTIONAL STUDIES

Instructions: In this section, a paper may present the same association with different degrees of adjustment. Please, abstract always the **maximally adjusted model** (EXCEPT if separate subgroups are being reported – in this case, abstract the **subgroup specific data** rather than the overall model).

70. Correlation Coefficient, variance and regression coefficient between clinic BP and urine protein or albumin:

	Correlation Coefficient **Clinic SBP** and Urine protein or albumin	Correlation Coefficient **Clinic DBP** and Urine protein or albumin	Variance Explained (R^2) **Clinic SBP** and Urine protein or albumin	Variance Explained (R^2) **Clinic DBP** and Urine protein or albumin	Regression Coefficient **Clinic SBP** and Urine protein or albumin	Regression Coefficient **Clinic DBP** and Urine protein or albumin
Estimate:						
SE						
95% CI:	to	to	to	to	to	to
P value:	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001

71. Clinic BP and urine protein or albumin:

	Correlation Coefficient	Variance Explained (R^2)	Regression Coefficient
Type of coefficient:			
Pearson (Parametric)	O	O	O
Spearman (Non-Parametric)	O	O	O
Unknown	O	O	O
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
ABPM	**G**	**G**	**G**
Self-measured BP	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, restricted etc.):			
None	O	O	O
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O

SECTION 4.2
SELF-BP AND URINE PROTEIN: CROSS-SECTIONAL STUDIES
Self-measured blood pressure associated with proteinuria/albuminuria (#2a)

72. Does study address self-measured BP and Urine protein or albumin?

O Yes
O **No, STOP and GO TO Question 89, page 38**

73. Self BP and Urine protein or albumin:

	Correlation Coefficient **Self SBP** and Urine protein	Correlation Coefficient **Self DBP** and Urine protein	Variance Explained (R^2) **Self SBP** and Urine protein	Variance Explained (R^2) **Self DBP** and Urine protein	Regression Coefficient **Self SBP** and Urine protein	Regression Coefficient **Self DBP** and Urine protein
Estimate:						
SE						
95% CI:	to	to	to	to	to	to
P value:	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001

74. Self BP and Urine protein or albumin:

	Correlation Coefficient	Variance Explained (R^2)	Regression Coefficient
Type of coefficient:			
Pearson (Parametric)	O	O	O
Spearman (Non-Parametric)	O	O	O
Unknown	O	O	O
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Clinic BP	**G**	**G**	**G**
ABPM	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, restricted etc.):			
None	O	O	O
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O

75. Did this study address the incremental gain in prediction of urine protein from self-measured devices beyond prediction from clinic BP alone? (e.g. are both variables in the same model?)

O Yes
O No
O Can't tell or not stated

CROSS-SECTIONAL COMPARISONS OF URINE PROTEIN IN NORMOTENSIVES, WHITE-COAT HYPERTENSIVES AND SUSTAINED HYPERTENSIVES-SELF BP
(Question #2a)

76. Does the study compare urine protein in normotensives, white-coat hypertensives and/or sustained hypertensives, assessed by SELF BP?

O Yes
O No, **STOP and GO TO Question 89, page 38**

Instructions:
- Only record other measurements if mean and SD are NOT provided
- If BP pressure measurements are provided for various positions- use only sitting BP for the following items.

77. **Blood pressure in clinic and SELF BP normotensives:**

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							

78. For clinic and SBPM normotensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

79. **Blood pressure in SELF BP white-coat hypertensives**

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							

80. For SELF BP white-coat hypertensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

81. **Blood pressure in SELF BP sustained**

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP SBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP DBP	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							

82. For clinic and SELF BP sustained hypertensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

URINE PROTEIN BY CATEGORY OF HYPERTENSION BASED ON SELF BP

83. Complete the following table for urine protein by category of hypertension:
– Only record other measurements if mean and SD are NOT provided

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic & SELF BP normotensive	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP White-coat Hypertensive	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							
SELF BP sustained hypertensives	_____	_____	_____	_____	____to_____	____to_____	____to___
O No Information Provided							

84. Proportion of clinic & SELF BP normotensives with LV hypertrophy:
_____(%) O Can't tell or not stated

85. Proportion of SELF BP white-coat hypertensives with LV hypertrophy:
_____(%) O Unknown

86. Proportion of SELF BP sustained hypertensives with LV hypertrophy:
__ ____(%) O Can't tell or not stated

DIFFERENCE IN URINE PROTEIN BY CATEGORY OF HYPERTENSION-BASED ON SELF BP

If study does not address difference in urine protein, **STOP and GO TO Question 89, page 38**

.

87. Complete the following table for the adjusted difference in urine protein between normotensives, white-coat hypertensives and sustained hypertensives assessed by self-measured BP:

	White-coat hypertensives minus normotensives (Self BP)	Sustained hypertensives minus normotensives (Self BP)	Sustained hypertensives minus white-coat hypertensives (Self BP)
Estimate:	_____	_____	_____
SE:	_____	_____	_____
95% CI:	_____to_____	_____to_____	_____to_____
P value:	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001
Adjustment:			
Unadjusted, Crude	O	O	O
Adjusted for:			
Clinic BP	O	O	O
Other, Specify:	_____	_____	_____
Other, Specify	_____	_____	_____

ODDS RATIOS OF PROTEINURIA IN NORMOTENSIVES, WHITE-COAT HYPERTENSIVES AND SUSTAINED HYPERTENSIVES-SELF BP

88. Complete the following table for the OR of proteinuria or albuminuria by category of hypertension, assessed by self BP:

	White-coat hypertensives vs. normotensives (Self BP)	Sustained Hypertensives vs. normotensives (Self BP)	Sustained hypertensives minus white-coat hypertensives (Self BP)
OR:			
95% CI:	_____to_____	_____to_____	_____to_____
P value:	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Clinic BP	**G**	**G**	**G**
Other, Specify	_____	_____	_____
Other, Specify	_____	_____	_____
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, etc.):			
None	O	O	
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other, Specify	_____	_____	_____
Other, Specify	_____	_____	_____
Unknown	O	O	O

Comments: Self BP and Proteinuria

SECTION 4.3
ABPM AND URINE PROTEIN: CROSS-SECTIONAL STUDIES

(ABPM and association with blood pressure-related target organ damage- #3a)

89. Does study address the association between ABPM and Urine protein?

O Yes

O No, **STOP this form is complete**

90. **24-Hour BP and Urine protein:**

	Correlation Coefficient **24-Hour SBP** and Urine protein	Correlation Coefficient **24-Hour DBP** and Urine protein	Variance Explained (R^2) **24-Hour SBP** and Urine protein	Variance Explained (R^2) **24-Hour DBP** and Urine protein	Regression Coefficient **24-Hour SBP** and Urine protein	Regression Coefficient **24-Hour DBP** and Urine protein
Estimate:						
SE:						
95% CI:	to	to	to	to	to	to
P value:	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001

91. **Daytime BP and Urine protein:**

	Correlation Coefficient **Day SBP** and Urine protein	Correlation Coefficient **Day DBP** and Urine protein	Variance Explained (R^2) **Day SBP** And Urine protein	Variance Explained (R^2) **Day DBP** and Urine protein	Regression Coefficient **Day SBP** and Urine protein	Regression Coefficient **Day DBP** and Urine protein
Estimate:						
SE:						
95% CI:	to	to	to	to	to	to
P value:	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > .05 O < 0.05 O < 0.01 O <0.001

92. Nighttime BP and Urine protein:

	Correlation Coefficient **Night SBP** and Urine protein	Correlation Coefficient **Night DBP** and Urine protein	Variance Explained (R^2) **Night SBP** And Urine protein	Variance Explained (R^2) **Night DBP** and Urine protein	Regression Coefficient **Night SBP** and Urine protein	Regression Coefficient **Night DBP** and Urine protein
Estimate:						
SE:						
95% CI:	to	to	to	to	to	to
P value	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001

93. **ABPM and Urine protein:**

	Correlation Coefficient	Variance Explained (R^2)	Regression Coefficient
Type of coefficient:			
Pearson (Parametric)	O	O	O
Spearman (Non-Parametric)	O	O	O
Unknown	O	O	O
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Clinic BP	**G**	**G**	**G**
SELF BP	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, restricted etc.):			
None	O	O	O
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Other:_____	**G**	**G**	**G**
Unknown	O	O	O

94. Did this study address the incremental gain in prediction of urine protein from ambulatory devices beyond prediction from clinic BP alone? (e.g. are both variables in the same model?)

O Yes
O No
O Can't tell or not stated

CROSS-SECTIONAL COMPARISON OF URINE PROTEIN IN NORMOTENSIVES, WHITE-COAT HYPERTENSIVES AND SUSTAINED HYPERTENSIVES-ABPM

95. Does the study compare urine protein in normotensives, white-coat hypertensives and/or sustained hypertensives, assessed by ABPM?

O Yes
O No, **STOP this form is complete**

BP BY CATEGORY OF HYPERTENSION

Instructions
- Only record other data if mean and SD are NOT provided
- If clinic BP measurements are provided for various positions- use only sitting BP

96. **Blood pressure in clinic and ABPM normotensives**:

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
24-Hour SBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
24-Hour DBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
Day SBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
Day DBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
Night SBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
Night DBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							

97. For clinic and ABPM normotensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

98. **Blood pressure in ABPM white-coat hypertensives**

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
24-Hour SBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
24-Hour DBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
Day SBP	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							
Day DBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
Night SBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							
Night DBP	_____	_____	_____	_____	_____to_____	_____to____	____to___
O No Information Provided							

99. For ABPM white-coat hypertensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

100. **Blood pressure in ABPM sustained hypertensives**

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic SBP	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							
Clinic DBP	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							
24-Hour SBP	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							
24-Hour DBP	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							
Day SBP	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							
Day DBP	_____	_____	_____	_____	_____to_____	_____to____	____to_
O No Information Provided							
Night SBP	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							
Night DBP	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							

101. For ABPM sustained hypertensives, indicate the following additional information:

Males: N_____ (%) _____
Race:
African-American: N_____ (%) _____
Asian N_____ (%) _____
White N_____ (%) _____
Other N_____ (%) _____
Mean Age: _____

URINE PROTEIN BY CATEGORY OF HYPERTENSION BASED ON ABPM

(Question #3a)

102. Complete the following table for urine protein by category of hypertension:
- Only report other variables if Mean and SD are NOT provided

	Mean	SD	SE	Median	IQR	95% CI	Range
Clinic & ABPM normotensives	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							
ABPM White-coat Hypertensives	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							
ABPM Sustained Hypertensives	_____	_____	_____	_____	_____to_____	_____to____	____to__
O No Information Provided							

103. Proportion of clinic & ABPM normotensives with proteinuria:
_____(%) O Unknown

104. Proportion of ABPM white-coat hypertensives with proteinuria:
_____(%) O Unknown

105. Proportion of ABPM sustained hypertensives with proteinuria:
_____(%) O Can't tell or not stated

DIFFERENCES IN URINE PROTEIN IN NORMOTENSIVES, WHITE-COAT HYPERTENSIVES AND SUSTAINED HYPERTENSIVES-ABPM

106. Does the study report differences in urine protein in normotensives, white-coat hypertensives and sustained hypertensives, assessed by ABPM?

O Yes

O No, **STOP this form is complete**

107. Complete the following table for the adjusted difference in urine protein between normotensives, white-coat hypertensives and sustained hypertensives assessed by ABPM:

	White-coat hypertenisves minus normotensives (ABPM)	Sustained hypertensives minus normotensives (ABPM)	Sustained hypertensives minus white-coat hypertensives (ABPM)
Estimate:	_____	_____	_____
SE:	_____	_____	_____
95% CI:	_____to_____	_____to_____	_____to_____
P value:	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001
Adjustment:			
Unadjusted, Crude	O	O	O
Adjusted for:			
Clinic BP	O	O	O
Other, Specify:	_____	_____	_____
Other, Specify	_____	_____	_____

ODDS RATIOS OF PROTEINURIA/ALBUMINURIA IN NORMOTENSIVES, WHITE-COAT HYPERTENSIVES AND SUSTAINED HYPERTENSIVES - ABPM

108. Does the study present the OR of proteinuria/albuminuria in normotensives, white-coat hypertensives or sustained hypertensives, assessed by ABPM?

O Yes

O No, **STOP this form is complete**

109. Complete the following table for the OR of proteinuria/albuminuria by category of hypertension assessed by ABPM:

	White-coat hypertenisves vs. normotensives (ABPM)	Sustained hypertensives vs. normotensives (ABPM)	Sustained hypertensives vs. white-coat hypertensives (ABPM)
OR:			
95% CI:	_____to_____	_____to_____	_____to_____
P value:	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001	_____ O > 0.05 O < 0.05 O < 0.01 O < 0.001
Adjustment:			
Unadjusted-Crude	O	O	O
Adjusted for (check all that apply):			
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Clinic BP	**G**	**G**	**G**
Other, Specify	_____	_____	_____
Other, Specify	_____	_____	_____
Unknown	O	O	O
Considered variables (matched, adjusted but not reported, etc.):			
None	O	O	
Age	**G**	**G**	**G**
Gender	**G**	**G**	**G**
Race	**G**	**G**	**G**
Weight, BMI or WHR	**G**	**G**	**G**
Other, Specify	_____	_____	_____
Other, Specify	_____	_____	_____
Unknown	O	O	O

Comments: ABPM and Urine Protein

Appendix F
Reproducibility of
White-coat Hypertension

Utility of Blood Pressure Monitoring Outside the Clinic Setting
Reproducibility of White-Coat Hypertension

Article ID#: _____

Reviewer 1: _____

Reviewer 2: _____

Article Eligibility

Article is not eligible for review because (check one):

O does not include human data

O not in English

O no original data

O meeting abstract (no full article for review)

O article does not apply to any of the research questions

O article does not include ambulatory or self-measured blood pressure

O article addresses reproducibility and has ≤ 20 patients

O device evaluation was the primary purpose of the study

O study population is exclusively pregnant women

O study population is exclusively children (<20 years of age)

O article addresses research question, but does not present data in an abstractable format.

O article addresses only the prevalence of dipping versus non-dipping and no other research questions

O article does not include reproducibility of white-coat hypertension

If yes, does article only address reproducibility of the difference between clinic, ABPM and/or self BP measurements O Yes O No

O other. specify: _____

If any item above checked -- STOP.
If article is eligible- complete pages 2-3

1. What technique was used to assess agreement between baseline and repeat blood pressure measurements?

O kappa statistic
O t-test
O pearson correlation coefficient
O other:_____
* If other, **STOP**- do not complete the rest of this form

2. Complete the following table for reproducibility of WCH defined by clinic and ABPM and/or self BP:

	Correlation Coefficient Baseline and Repeat WCH **(ABPM)**	Correlation Coefficient Baseline and Repeat WCH **(Self BP)**	Kappa Statistic Baseline and Repeat WCH **(ABPM)**	Kappa Statistic Baseline and Repeat WCH **(Self BP)**	t-test Baseline and Repeat WCH **(ABPM)**	t-test Baseline and Repeat WCH **(Self BP)**
Estimate:						
SE:						
95% CI:	to	to	to	to	to	to
P value:	_____	_____	_____	_____	_____	_____
	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001	O > 0.05 O < 0.05 O < 0.01 O < 0.001

3. Was there any evidence of inconsistencies in the blood pressure protocol between baseline and repeat BP measurements?

? different measurement technique
? different number of measurements
? different setting/location
? different observer
? different blood pressure device
? different time of day
? other difference: _____
O No observed differences

4. What was the percentage of white-coat hypertensives defined by **clinic and ABPM** at baseline and follow-up? (% WCH is defined as percentage of all hypertensives identified as having WCH)

WCH at Baseline	N _____ % _____	
WCH at Follow-up	N _____ % _____	
WCH at Both	N _____ % _____	O Can't tell or not stated

5. What was the percentage of white-coat hypertensives defined by **clinic and self BP** at baseline and follow-up? (% WCH is defined as percentage of all hypertensives identified as having WCH)

WCH at Baseline	N _____ % _____	
WCH at Follow-up	N _____ % _____	
WCH at Both	N _____ % _____	O Can't tell or not stated

6. What was the mean time interval between baseline BP and the last follow-up BP? (if multiple follow-up measurements are provided- use only the first and last set of measurements)

_____ O days
O weeks
O months
O years

Comments:

Data Collection Items - Spread Sheet for Longitudinal Studies (questions #2b and #3b)

Author
Year of Publication
Group
Whole/Subgroup
Total Sample Size

Study Description:
Duration of follow up (Years):
Mean
SD

Outcome:
Description
Number of Events

Clinic Blood Pressure as Predictor
Systolic Blood Pressure
Contrast
Label
Number
P Value
95% CI

Diastolic Blood Pressure
Contrast
Label
Number
P Value
95% CI

Self-measured Blood Pressure as Predictor
Systolic Blood Pressure
Contrast
Label
Number
P Value
95% CI

Diastolic Blood Pressure
Contrast
Label
Number

P Value
95% CI

Daytime Ambulatory Blood Pressure Measurement as Predictor

Systolic Blood Pressure

Contrast
Label
Number
P Value
95% CI

Diastolic Blood Pressure

Contrast
Label
Number
P Value
95% CI

Nighttime Ambulatory Blood Pressure Measurement as Predictor

Systolic Blood Pressure

Contrast
Label
Number
P Value
95% CI

Diastolic Blood Pressure

Contrast
Label
Number
P Value
95% CI

24 Hour Ambulatory Blood Pressure Measurement as Predictor

Systolic Blood Pressure

Contrast
Label
Number
P Value
95% CI

Diastolic Blood Pressure

Contrast
Label
Number
P Value
95% CI

Pattern as Predictor:

White Coat Hypertension

Contrast
Label
Number
P Value
95% CI

Non Dippers

Contrast
Label
Number
P Value
95% CI

Incremental Gain Beyond Clinic

Ambulatory

Tested
Gain

Self-measured Blood Pressure

Tested
Gain

Adjustments

Data Adjusted For

Age
Gender
Smoking
Cholesterol
Others

Comments

Data Collection Items - Spread Sheet for Clinical Trials (questions #2d and #3d)

First Author
Year of Publication
Total Sample Size

Study Objectives
- Objective

Follow Up (Months)
- Mean
- SD

The following items were abstracted for each randomized group:
- Group name
- N
- Description

Age (Years)
- Mean
- SD

Patient Demographic Characteristics
- % Male
- % African American
- % White
- % Other Race
- % Diabetics
- % On BP Medication
- % On Dialysis
- % History of Cardiovascular Disease
- % Current Smokers

BP Measurement and Management by Group
- Type of BP Device
- Frequency of Measurement
- Medication Titration
- SBP Goal
- DBP Goal
- Other Co-interventions
- Number of Clinic BP Visits at the End of Follow-up

Office Systolic BP by Group (mmHg)
- Baseline BP
  - Mean
  - SD
- Follow-up
  - Mean
  - SD
- Difference from Baseline
  - Mean
  - SD
- Between Group Difference (comparison with control group)
  - Mean
  - SD
  - P Value

Offfice Diastolic Blood Pressure (mmHg)

- Baseline BP
  - Mean
  - SD
- Follow-up
  - Mean
  - SD
- Difference from Baseline
  - Mean
  - SD
- Between Group Difference (comparison with control group)
  - Mean
  - SD
  - P Value

Self-Measured Systolic Blood Pressure (mmHg)

- Baseline BP
  - Mean
  - SD
- Follow-up
  - Mean
  - SD
- Difference from Baseline
  - Mean
  - SD
- Between Group Difference (comparison with control group)
  - Mean
  - SD
  - P Value

Self-Measured Diastolic Blood Pressure (mmHg)

- Baseline BP
  - Mean
  - SD
- Follow-up
  - Mean
  - SD
- Difference from Baseline
  - Mean
  - SD
- Between Group Difference (comparison with control group)
  - Mean
  - SD
  - P Value

Daytime Ambulatory Systolic Blood Pressure (mmHg)

- Baseline BP
  - Mean
  - SD
- Follow-up
  - Mean
  - SD
- Difference from Baseline
  - Mean
  - SD

Between Group Difference (comparison with control group)
Mean
SD
P Value

Daytime Ambulatroy Diastolic Blood Pressure (mmHg)
Baseline BP
Mean
SD
Follow-up
Mean
SD
Difference from Baseline
Mean
SD
Between Group Difference (comparison with control group)
Mean
SD
P Value

Night time Ambulatory Systolic Blood Pressure (mmHg)
Baseline BP
Mean
SD
Follow-up
Mean
SD
Difference from Baseline
Mean
SD
Between Group Difference (comparison with control group)
Mean
SD
P Value

Night time Ambulatory Diastolic Blood Pressure (mmHg)
Baseline BP
Mean
SD
Follow-up
Mean
SD
Difference from Baseline
Mean
SD
Between Group Difference (comparison with control group)
Mean
SD
P Value

24 hour Ambulatory Systolic Blood Pressure (mmHg)
Baseline BP
Mean
SD
Follow-up
Mean

SD
Difference from Baseline
Mean
SD
Between Group Difference (comparison with control group)
Mean
SD
P Value

24 hour Ambulatory Diastolic Blood Pressure (mmHg)
Baseline BP
Mean
SD
Follow-up
Mean
SD
Difference from Baseline
Mean
SD
Between Group Difference (comparison with control group)
Mean
SD
P Value

BP Control (% at Goal):
Definition of BP Control:
Baseline (%)
Follow-up (%)
Improvement (%)
P Value

Compliance
Definition
Baseline (%)
Follow-up (%)
Improvement (%)
P Value

Medication Use (% on Number of Medication)
Baseline (%)
Follow-up (%)
Improvement (%)
P Value

Medication Use (Number of Anti-Hypertensive Medications)
Baseline
Follow-up
Improvement
P Value

Other Outcomes

Comments