Hypertension is a powerful risk factor for fatal and nonfatal cardiovascular disease events. Data from observational studies indicate that this risk is continuous, without evidence of a threshold, down to blood pressures as low as 115/75 mm Hg.1 Randomized controlled trials have convincingly shown that treatment of hypertension reduces the risk of stroke, coronary heart disease, congestive heart failure, and mortality.2,3 Because hypertension currently affects 1 in 4 American adults (∼65 million people in 1999 to 2000)4 and may affect >90% of individuals during their lifetimes,5 adequate control of blood pressure is of enormous public health importance. However, recent studies indicate that as many as two thirds of those with hypertension in the United States are either untreated or undertreated.6 Studies based on national data and community cohorts have shed light on the reasons underlying this poor control, but several questions remain unanswered. In this article, we review contemporary data on the epidemiology of uncontrolled hypertension in the United States by (1) defining what constitutes “controlled hypertension”; (2) describing the current magnitude of the problem, including temporal trends; (3) summarizing the public health consequences of uncontrolled hypertension; (4) examining the clinical correlates of uncontrolled hypertension and appraising the patient- and physician-related factors related to poor control of blood pressure; and (5) identifying future research directions, including potential interventions to address this problem. In this article, “uncontrolled hypertension” signifies blood pressure that is inadequately treated rather than blood pressure that is resistant to treatment, as might be observed with secondary causes of hypertension such as renal artery stenosis.

Definition: What Is Optimal Blood Pressure Control?
The definition of high blood pressure has changed over time and differs between guidelines proposed by expert bodies. Variation in the definition of hypertension influences the number of people classified as having uncontrolled hypertension and may contribute to uncertainty among clinicians (Table 1).8 The 1977 report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC) regarded a blood pressure ≥160/95 mm Hg as elevated, although treatment recommendations were based primarily on the diastolic blood pressure.9 The 1980 JNC report defined hypertension based on a diastolic blood pressure threshold alone (90 mm Hg).10 In 1984, this definition was changed again, to a blood pressure ≥140/90 mm Hg.11 In JNC VI (1997), a lower threshold of 130/85 mm Hg was recommended for individuals with diabetes mellitus.12 JNC VII lowered this target for individuals with diabetes or chronic kidney disease, to 130/80 mm Hg,3 bringing this threshold in agreement with recommendations of the American Diabetes Association and the National Kidney Foundation.13,14 However, the National Committee for Quality Assurance (NCQA), an organization that issues periodic “report cards” for managed care organizations, continues to use a cut point of 140/90 mm Hg in both diabetic and nondiabetic patients.15

Individuals with evidence of target organ damage such as left ventricular hypertrophy or who have experienced clinical sequelae such as heart failure are at particularly high risk of cardiovascular events, and use of lower blood pressure thresholds for these individuals was endorsed by JNC VI.12 The European Society of Hypertension/European Society of Cardiology guidelines also recommend that treatment thresholds account for baseline cardiovascular risk,16 similar to the approach based on absolute risk contained in the National Cholesterol Education Program (NCEP) guidelines.17 However, in an effort to simplify treatment guidelines, the JNC VII report recommends use of an alternate blood pressure threshold only for patients with diabetes or chronic kidney disease.5

Magnitude of the Problem
Data on the prevalence of controlled and uncontrolled hypertension are available from national cross-sectional surveys, epidemiological investigations, community studies, health maintenance organizations, and reports of physician office practices (Table 2).6,18–42

From the Framingham Heart Study, Framingham, Mass (T.J.W., R.S.V.); Cardiology Division (T.J.W.), Massachusetts General Hospital, Harvard Medical School, Boston, Mass; and Sections of Cardiology and Preventive Medicine (R.S.V.), Boston Medical Center, Boston University School of Medicine, Boston, Mass.

Guest Editor for this article was Donna K. Arnett.

Correspondence to Ramachandran S. Vasan, MD, Framingham Heart Study, 73 Mt Wayte Ave, Suite 2, Framingham, MA 01702. E-mail vasan@bu.edu

(Circulation. 2005;112:1651-1662.)

© 2005 American Heart Association, Inc.

Circulation is available at http://www.circulationaha.org

DOI: 10.1161/CIRCULATIONAHA.104.490599

1651
TABLE 1. Definitions of Blood Pressure Control

<table>
<thead>
<tr>
<th>Year</th>
<th>Without Diabetes, mm Hg</th>
<th>With Diabetes, mm Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>JNC 6</td>
<td>1997</td>
<td>&lt;140/90*</td>
</tr>
<tr>
<td>JNC 7</td>
<td>2003</td>
<td>&lt;140/90</td>
</tr>
<tr>
<td>HEDIS</td>
<td>2000–2004</td>
<td>≤140/90</td>
</tr>
<tr>
<td>ADA/NKF</td>
<td>2003</td>
<td>...</td>
</tr>
<tr>
<td>ESH/ESC</td>
<td>2003</td>
<td>&lt;140/90*</td>
</tr>
</tbody>
</table>

ADA indicates American Diabetes Association; NKF, National Kidney Foundation; ESH, European Society of Hypertension; and ESC, European Society of Cardiology. Adapted from Singer et al48 with permission of the American Heart Association.

*Initiation of therapy for individuals with cardiac disease or multiple risk factors is recommended at a blood pressure of ≥130/85 mm Hg.12,16
†Also applies to those with chronic kidney disease.
‡Blood pressure above which antihypertensive therapy is recommended by these guidelines.

Prevalence of Uncontrolled Hypertension in National Surveys

The most comprehensive information concerning the prevalence of uncontrolled hypertension in the United States derives from population-based surveys conducted by the National Center for Health Statistics.43 Based on data collected in the 1999 to 2000 National Health and Nutrition Examination Survey (NHANES), the estimated overall prevalence of hypertension in the United States was 23.1%. Based on 1999 data, 31.1% of the hypertensive population had blood pressure values ≥140/90 mm Hg.46

In the overall sample of the NHANES III had blood pressure ≥140/90 mm Hg. Only 11% had blood pressure controlled to <130/85 mm Hg. In a cohort of patients with end-stage renal disease on dialysis, the prevalence of hypertension was nearly 90%, and only 30% had blood pressure controlled to ≤150/85 mm Hg.51

Individuals with established coronary heart disease make up another high-risk group in which aggressive control of blood pressure may be warranted. Recent data suggest that antihypertensive therapy may slow the progression of coronary heart disease even for individuals with baseline blood pressures ≥140/90 mm Hg.52 However, there are relatively few data on the prevalence of hypertension and rates of control among individuals with coronary heart disease. One study of hypertensive patients attending internal medicine clinics noted that blood pressure was treated and controlled (<140/90 mm Hg) in ≈40% of those with coronary artery disease.40 Another study of coronary heart disease patients at Veterans Administration hospitals found that <40% had blood pressures of ≤130/85 mm Hg.53

Temporal Trends in Hypertension Control

Trends observed in NHANES and National Health Examination Survey data since 1960 are displayed in the Figure. The largest increases in awareness, treatment, and control occurred between the 1976 to 1980 and 1988 to 1991 surveys. Although statistically significant increases in treatment and control have occurred since 1988, the rate of rise has been modest. Based on the most recent NHANES data, it appears that the goal of having 50% of hypertensive adults treated and controlled (<140/90 mm Hg) in 1990 to 1995 to 43% in 1999.32 A more recent time period is covered by the HEDIS/NCQA report, which noted an increase of 10 to 15 percentage points in control rates among the participating health plans that reported their data between 2000 and 2003.15
Caveats to Be Considered When Interpreting Data on Hypertension Control Rates
A number of factors contribute to the variation in hypertension control rates reported in existing studies (Table 2). Most noticeably, these studies are based on different patient populations, ranging from the nationally representative NHANES database to several inner-city samples. Whereas population-based data enable an assessment of national rates of hypertension control, the reasons for poor control are heterogeneous and may be easier to examine in more narrowly defined patient samples. Secular trends in blood pressure definitions and hypertension control rates may also contribute to variability between studies. For instance, inevitable lags in the dissemination of guidelines may affect measures of adherence after a guideline change.

Several methodological issues also warrant consideration. In NHANES and most epidemiological studies, the definition of hypertension is based on the blood pressure recorded at the study examination and the use of antihypertensive medications. Failure to account for use of nonpharmacological therapies may misclassify some individuals as nonhypertensive when they are in fact treated and controlled, resulting in an underestimation of hypertension control rates. In contrast, several studies, including the NCQA report, rely on International Classification of Disease, ninth revision, diagnoses of hypertension or diagnoses contained in the medical record, an approach that may inflate estimates of hypertension control for 2 reasons. Patients with elevated blood pressure who do not carry the diagnosis of hypertension may be misclassified as nonhypertensive. Conversely, some patients with a remote chart diagnosis of hypertension who neither require therapy nor have elevated blood pressure would be considered controlled in these studies.

Within-person variability in blood pressure introduces another potential source of misclassification of hypertension status that may result in an overestimation of uncontrolled hypertension. Multiple blood pressure measurements, particularly on separate occasions, may reduce this risk. In NHANES III, nearly 80% of participants had up to 6 blood pressure measurements on 2 occasions. A single examination was performed for the most recent NHANES, but >90% of participants had 3 blood pressure measurements at this visit. Although other studies have relied predominantly on 1 or 2 measurements, investigators from the Rochester Epidemiology Project found that hypertension rates were similar whether a single measurement or the average of 6 measurements on 2 occasions was used. Similarly, Alexander and colleagues found that use of a single clinic blood pressure yielded estimates of hypertension control comparable to those based on multiple blood pressures, except when the definition of control required >75% of blood pressures to be <140/90 mm Hg.

Although taking the blood pressure multiple times can attenuate the influence of within-person variability because of physiological variation or measurement error, several sources of nonrandom variation may also exist. The most important of these is the phenomenon of “white-coat hypertension,” which may lead to an overestimation of hypertension prevalence. Assessment of ambulatory blood pressures may provide a better index of control, although such measures are rarely available in epidemiological settings. Another consideration is end-digit preference, the tendency to round blood pressures to the closest 5 or 10 mm Hg. Green and colleagues noted that a minor change in the definition of blood pressure control, from <140/90 to ≤140/90 mm Hg, produced a substantial increase in the proportion of patients controlled in a clinic sample. This observation is relevant because HEDIS changed its definition of hypertension control from <140/90 to ≤140/90 mm Hg in 2000, whereas JNC and NHANES have stayed with the more stringent definition of <140/90 mm Hg.

These issues notwithstanding, most studies suggest that more than half of those with hypertension in this country have inadequate blood pressure control. National gains in control rates have been modest in the last decade, suggesting that a substantial missed opportunity continues to exist for the prevention of cardiovascular disease in this country.

Public Health Implications of Uncontrolled Hypertension
The high prevalence of uncontrolled hypertension suggests that a substantial number of cardiovascular events could be prevented by improved blood pressure control. The most recent NHANES data indicate that slightly more than half of the individuals with uncontrolled hypertension are not on any antihypertensive medications. The benefits of pharmacological treatment for these patients are well established. Meta-analyses of randomized placebo-controlled trials indicate that antihypertensive therapy reduces the risk of stroke by ~30%, coronary heart disease by 10% to 20%, congestive heart failure by 40% to 50%, and total mortality by 10%. Estimating the benefits of improved blood pressure control for patients already on therapy is more difficult because few trials evaluating different blood pressure targets have been performed. Also, it remains controversial whether the risk of cardiovascular events is related solely to the blood pressure achieved or also to the manner in which it is achieved. Nonetheless, blood pressure control rates in randomized trials are typically quite high, suggesting that improved control rates would be necessary for the benefits of antihypertensive treatment to be demonstrated in randomized trials.

Several studies have attempted to quantify the societal cost of uncontrolled hypertension in clinical and financial terms. Using NHANES III data, Wong and colleagues estimated that control of hypertension to levels recommended by the JNC could prevent 19% to 56% of coronary heart disease events in men and 31% to 57% of coronary heart disease events in women, depending on the blood pressure achieved. The NCQA estimates that 15 000 to 26 000 deaths could be averted annually if everyone received the same care as that delivered in the top 10th percentile of health plans. Flack and colleagues estimate that the direct medical expenditures attributable to inadequate blood pressure control is nearly $1 billion per year. These costs do not include the workforce burdens imposed by excess sick days and increased numbers of physician office visits.

Factors Associated With Inadequate Blood Pressure Control
Studies spanning several decades have identified myriad factors related to poor blood pressure control. These factors can be divided,
somewhat arbitrarily, into patient-related factors and physician-related factors (Table 3). Patient-related factors include access to health care, compliance, and comorbidities. Physician-related factors include knowledge base, perceptions about the care delivered, and practice patterns. Earlier reports and guidelines relating to uncontrolled hypertension emphasized patient-related factors, particularly those having to do with access to care and compliance. However, recent data indicate that physician practices are at least as responsible for this problem, if not more so.31,64 In the following section, we initially summarize patient-related factors and then discuss physician-related factors that contribute to the burden of uncontrolled hypertension in the community.

### TABLE 2. Hypertension Control in the United States: Selected Studies Published Since 1990

<table>
<thead>
<tr>
<th>Authors</th>
<th>Time Period</th>
<th>Setting</th>
<th>Overall, n</th>
<th>Hypertensives, n</th>
<th>Mean Age, Overall, y*</th>
<th>Women, Overall, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>National surveys, epidemiological studies, and community studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Svetkey et al18</td>
<td>1986–1987</td>
<td>Epidemiological cohort in North Carolina</td>
<td>2473</td>
<td>2473</td>
<td>73</td>
<td>65</td>
</tr>
<tr>
<td>Meissner et al21</td>
<td>1993–1995</td>
<td>Olmsted County, Minn</td>
<td>636</td>
<td>370</td>
<td>66</td>
<td>50</td>
</tr>
<tr>
<td>Psaty et al22</td>
<td>1999</td>
<td>Biracial elderly cohort (Cardiovascular Health Study)</td>
<td>2015</td>
<td>2015</td>
<td>65+</td>
<td>NR</td>
</tr>
<tr>
<td>Inciardi et al23</td>
<td>1999</td>
<td>Elderly individuals in an affluent suburb</td>
<td>432</td>
<td>432</td>
<td>79</td>
<td>58</td>
</tr>
<tr>
<td>Hajjar and Kotchen6</td>
<td>1999–2000</td>
<td>Population-based sample (NHANES)</td>
<td>5448</td>
<td>1565‡</td>
<td>44</td>
<td>52</td>
</tr>
<tr>
<td>Studies in urban settings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone et al26</td>
<td>1992</td>
<td>Urban black neighborhood</td>
<td>854</td>
<td>854</td>
<td>54</td>
<td>62</td>
</tr>
<tr>
<td>Kotchen et al27</td>
<td>NR</td>
<td>Inner-city households in Milwaukee</td>
<td>583</td>
<td>245§</td>
<td>18+</td>
<td>62</td>
</tr>
<tr>
<td>Hill et al28</td>
<td>NR</td>
<td>Young urban black men enrolled in a randomized trial</td>
<td>309</td>
<td>309</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>Stockwell et al29</td>
<td>1992</td>
<td>Voluntary employee blood pressure screening</td>
<td>409</td>
<td>409</td>
<td>45–74</td>
<td>57</td>
</tr>
<tr>
<td>Studies in managed-care or practice organizations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barker et al30</td>
<td>1988</td>
<td>Elderly HMO patients</td>
<td>480</td>
<td>480</td>
<td>65+</td>
<td>59</td>
</tr>
<tr>
<td>Berlowitz et al31,32</td>
<td>1990–1995</td>
<td>5 VA sites in New England</td>
<td>800</td>
<td>800</td>
<td>66</td>
<td>0</td>
</tr>
<tr>
<td>Alam and Barri34</td>
<td>1998–1999</td>
<td>VA in Arkansas</td>
<td>585</td>
<td>585</td>
<td>65</td>
<td>0</td>
</tr>
<tr>
<td>Andrade et al36</td>
<td>1999</td>
<td>HMO</td>
<td>681</td>
<td>681</td>
<td>66</td>
<td>55</td>
</tr>
<tr>
<td>Borzecki et al32</td>
<td>1999</td>
<td>10 VA sites</td>
<td>981</td>
<td>981</td>
<td>65</td>
<td>3</td>
</tr>
<tr>
<td>Knight et al37</td>
<td>NR</td>
<td>Managed-care organization, referral hospital, and VA</td>
<td>525</td>
<td>525</td>
<td>65</td>
<td>36</td>
</tr>
<tr>
<td>Jackson et al38</td>
<td>1998–2001</td>
<td>Blacks in 10 managed-care organizations</td>
<td>440</td>
<td>440</td>
<td>60</td>
<td>66</td>
</tr>
<tr>
<td>Practice-based studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hicks et al40</td>
<td>2001–2002</td>
<td>12 General medicine clinics</td>
<td>6109</td>
<td>6109</td>
<td>60</td>
<td>68</td>
</tr>
<tr>
<td>Majernick et al41</td>
<td>2002</td>
<td>Family practice clinic</td>
<td>631</td>
<td>631</td>
<td>64</td>
<td>55</td>
</tr>
</tbody>
</table>

HTN indicates hypertension; NR, not reported; VA, Veterans Affairs; HMO, health maintenance organization; ICD, International Classification of Disease; and BP, blood pressure. When data from a study cover multiple time periods, the most recent time period is selected. In addition, when an intervention is being studied, the preintervention rates are reported.

*When the mean age is not reported, the age range or age inclusion criterion is included if available.
†Data were reported only for the diastolic blood pressure threshold to reflect guidelines at the time.
‡NHANES data are weighted to US population.
§Estimated.
¶When criterion for control is defined as blood pressure <140/90 mm Hg, proportion of patients with control is 7%.
¶¶When criterion for control is defined as blood pressure <140/90 mm Hg at >75% of visits, then proportion of patients with control is 14%.
Patient-Related Factors

Clinical Correlates: Age and Sex

Various patient characteristics have been associated with uncontrolled hypertension, including age, obesity, and lack of exercise. These characteristics are risk factors for hypertension itself and presumably contribute directly to difficult blood pressure control. Hyman and Pavlik cited advanced age as the most important correlate of uncontrolled hypertension, accounting for an estimated 32% of cases among those aware of this condition in NHANES III. Age is most strongly related to systolic blood pressure, and isolated systolic hypertension accounts for the vast majority of cases of uncontrolled hypertension in individuals >60 years of age.

Data on the association of gender with hypertension control have been conflicting. In NHANES III (1988–1994), rates of awareness and control among hypertensives were significantly higher in women compared with men. However, in the 1999 to 2000 NHANES, there was no significant difference between men and women as a result of significant increases in treatment and control rates in men. Several studies of ambulatory practices have found female gender to be a significant predictor of blood pressure control in multivariable models, but other studies have reported either no difference or better control in men.

<table>
<thead>
<tr>
<th>Source of Data</th>
<th>Definition of HTN, mm Hg</th>
<th>Definition of Control, mm Hg</th>
<th>Control, Among Those With HTN, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field visit</td>
<td>&gt;160/90 or HTN medications</td>
<td>Diastolic &lt;90</td>
<td>78†</td>
</tr>
<tr>
<td>Home interview and clinic visit</td>
<td>≥140/90 or HTN medications</td>
<td>&lt;140/90</td>
<td>50</td>
</tr>
<tr>
<td>Clinic visit</td>
<td>≥140/90 or HTN medications</td>
<td>&lt;140/90</td>
<td>29</td>
</tr>
<tr>
<td>Home interview and blood pressure measurement</td>
<td>≥140/90 or self-reported HTN</td>
<td>&lt;140/90</td>
<td>23</td>
</tr>
<tr>
<td>Interview</td>
<td>≥140/90 or HTN medications</td>
<td>&lt;140/90</td>
<td>49</td>
</tr>
<tr>
<td>Chart review</td>
<td>Diagnosis of HTN or ≥140/90 on 2 visits</td>
<td>&lt;140/90</td>
<td>36</td>
</tr>
<tr>
<td>Interview and examination</td>
<td>≥140/90 or HTN medications</td>
<td>&lt;140/90; &lt;130/85 for diabetes</td>
<td>31‡</td>
</tr>
<tr>
<td>Chart review</td>
<td>Diagnosis of HTN in medical record</td>
<td>Mean BP &lt;140/90</td>
<td>42</td>
</tr>
<tr>
<td>Interview</td>
<td>Self-reported diagnosis of HTN</td>
<td>&lt;140/90</td>
<td>12</td>
</tr>
<tr>
<td>Screening examination</td>
<td>≥140/90 or HTN medications</td>
<td>&lt;160/95</td>
<td>34</td>
</tr>
<tr>
<td>Chart review</td>
<td>≥160/95 or HTN medications</td>
<td>&lt;140/90</td>
<td>31</td>
</tr>
<tr>
<td>Administrative data, medical records</td>
<td>Diagnosis of HTN in electronic medical record</td>
<td>Mean blood pressure from all visits &lt;140/90</td>
<td>30¶</td>
</tr>
<tr>
<td>Electronic medical record and chart review</td>
<td>≥140/90 or HTN medications</td>
<td>Mean BP from 2 visits &lt;140/90</td>
<td>58</td>
</tr>
<tr>
<td>Chart review</td>
<td>Identified by ICD-9 diagnosis</td>
<td>BP in 50% of visits &lt;140/90; &lt;130/85 for diabetes</td>
<td>36</td>
</tr>
<tr>
<td>Chart review</td>
<td>Pharmacy claims and diagnosis confirmed by chart review</td>
<td>&lt;140/90; &lt;130/85 for diabetes</td>
<td>38</td>
</tr>
<tr>
<td>Electronic medical record</td>
<td>Identified by ICD-9 diagnosis</td>
<td>≥140/90</td>
<td>43</td>
</tr>
<tr>
<td>Chart review and survey</td>
<td>HTN medications or diagnosis of HTN in medical record</td>
<td>&lt;140/90</td>
<td>39</td>
</tr>
<tr>
<td>Chart review</td>
<td>Medical and pharmacy claims and diagnosis confirmed by chart review</td>
<td>&lt;140/90; &lt;130/85 for diabetes</td>
<td>36</td>
</tr>
<tr>
<td>Electronic medical record</td>
<td>Diagnosis of HTN in electronic medical record</td>
<td>&lt;140/90; &lt;130/85 for diabetes</td>
<td>50</td>
</tr>
<tr>
<td>Electronic medical record</td>
<td>Identified by ICD-9 diagnosis</td>
<td>&lt;140/90; &lt;130/85 for diabetes or renal failure</td>
<td>37</td>
</tr>
<tr>
<td>Clinic visit</td>
<td>Diagnosis of HTN and ≥140/90 or HTN medications</td>
<td>&lt;140/90; &lt;130/80 for diabetes</td>
<td>35</td>
</tr>
<tr>
<td>Clinic visit</td>
<td>Diagnosis of HTN by clinic provider</td>
<td>&lt;130/85</td>
<td>29</td>
</tr>
</tbody>
</table>
Race/Ethnicity
Race is related in a complex manner to hypertension control because it may interact with multiple other factors, including access to care, susceptibility to hypertension, and comorbid conditions such as obesity. In the 1999 to 2000 NHANES, rates of control were lower in Mexican Americans (17.7%) compared with non-Hispanic whites (33.4%) and non-Hispanic blacks (28.1%). The difference between Mexican Americans and non-Hispanic whites was statistically significant in all age and gender subgroups, although the comparisons did not account for other sociodemographic characteristics. Low rates of hypertension treatment or control in Hispanic individuals have also been reported in other studies. Data on blood pressure control in blacks have been inconclusive, with some studies suggesting that blacks have poorer blood pressure control than whites after multivariable adjustment. Among blacks, additional factors such as immigrant status and geographic region correlate with poor blood pressure control, suggesting that cultural or sociodemographic characteristics may contribute to observed differences between racial groups.

Access to Health Care and Socioeconomic Status
Studies based on NHANES data and clinical databases have helped to change the perception that patients with uncontrolled hypertension are typically uninsured or have restricted access to health care. In fact, 92% of participants with uncontrolled hypertension in NHANES III had health insurance, and 86% reported a regular source of care. Individuals in this latter group made an average of 4.3 visits to physicians per year. In another study, Berlowitz et al examined 800 hypertensive men who received regular medical care at Veterans Administration hospitals and found that 25% had adequate blood pressure control. Whereas these data suggest that access to health care and socioeconomic status are not the predominant causes of uncontrolled hypertension nationally, they do not negate the importance of these factors for some patients. For instance, in NHANES III, private insurance (versus no insurance) and a regular healthcare provider were multivariable predictors of hypertension control, despite the fact that most individuals with uncontrolled hypertension reported having both. Similarly, in a study of hypertension-related clinic visits to community practices, self-pay or free-care status was associated with a lower likelihood of blood pressure control in multivariable models. Studies in inner-city and minority populations have also emphasized the contribution of inadequate health insurance and lower socioeconomic status to inadequate blood pressure control.

Compliance Issues
Patient noncompliance may contribute to poor blood pressure control, although the importance of this factor at a community level is difficult to assess. Although concerns about patient compliance are infrequently cited by physicians as a reason for not starting or escalating hypertensive therapy, pill-counting studies suggest that medication compliance is overestimated by patients, indicating that self-report is an

TABLE 3. Causes of Uncontrolled Hypertension

<table>
<thead>
<tr>
<th>Patient Factors</th>
<th>Physician Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restricted access to health care</td>
<td>Lack of knowledge about guidelines</td>
</tr>
<tr>
<td>Lack of health insurance</td>
<td>BP thresholds</td>
</tr>
<tr>
<td>Lack of a regular provider</td>
<td>Isolated systolic hypertension</td>
</tr>
<tr>
<td>Increased susceptibility to hypertension</td>
<td>Threshold for diabetic patients</td>
</tr>
<tr>
<td>Advanced age</td>
<td>Use of monotherapy in patients in whom BP is difficult to control</td>
</tr>
<tr>
<td>Obesity</td>
<td>Overestimation of adherence to guidelines</td>
</tr>
<tr>
<td>Noncompliance with therapy</td>
<td>Disagreement with guidelines</td>
</tr>
<tr>
<td>Knowledge deficits</td>
<td>Isolated systolic hypertension</td>
</tr>
<tr>
<td>Medication cost</td>
<td>Concern about the J curve</td>
</tr>
<tr>
<td>Complicated regimens</td>
<td>Concern about medication side effects</td>
</tr>
<tr>
<td>Side effects</td>
<td>Belief that office BP tends to be higher than home BP</td>
</tr>
<tr>
<td>Poor physician-patient</td>
<td>Reluctance to treat an asymptomatic condition</td>
</tr>
<tr>
<td>communication</td>
<td>Lack of time at office visits</td>
</tr>
</tbody>
</table>

BP indicates blood pressure.
unreliable way to assess adherence to therapies.77 Several older studies suggest an association between compliance and blood pressure control.78–80 Reasons for poor compliance may include insufficient patient knowledge, inaccurate perceptions, medication cost, and side effects of therapy.81–84 In 1 national telephone survey, 68% of respondents indicated that hypertension was not “a serious health concern,” and nearly half did not know their blood pressure despite the fact that the vast majority had a measurement within 4 months of the survey.81

Physician-Related Factors
Several studies have scrutinized the role of physicians in promoting poor blood pressure control. In the study of Berlowitz and colleagues,31 physicians caring for patients in Veterans Administration hospitals escalated antihypertensive therapy in only 21.6% of visits in which a systolic blood pressure ≥160 mm Hg and diastolic blood pressure <90 mm Hg was documented. At visits with systolic and diastolic blood pressures ≥155 and ≥90 mm Hg, respectively, medications were increased only 25.6% of the time. Similarly, in a study based in a large, Midwestern group practice, pharmacological therapy was started or intensified in only 38% of visits in which uncontrolled hypertension was documented.64 The most common reason cited by these physicians for not changing medication was satisfaction with the current blood pressure or response to existing therapy. Although these cross-sectional data cannot exclude the possibility that medication changes were made at subsequent visits, longitudinal data from the Framingham Heart Study indicate that ≈60% of individuals with uncontrolled hypertension will continue to have inadequate control after 4 years, despite opportunities to increase therapy in the interim.85

Several factors may account for physicians’ lack of adherence to practice guidelines for hypertension,86 including knowledge deficits,87 overestimation of compliance with guidelines,87 disagreement with guidelines,64,88 or reluctance to make therapeutic changes, a behavior labeled “clinical inertia.”79 In a national survey of 316 primary care physicians, 41% were unfamiliar with current JNC guidelines, and 43% would not initiate pharmacological therapy unless the systolic blood pressure exceeded 160 mm Hg.85 Respondents were also less aggressive with hypothetical older patients than with younger patients. Similar findings have been reported in other surveys of healthcare professionals.64,90 Compounding this problem is the tendency for physicians to overestimate their compliance with guidelines. In a survey of primary care providers at Veterans Affairs medical centers, physicians overestimated the proportion of their patients with controlled blood pressure by >30%.87

Reluctance of some physicians to adopt the systolic blood pressure thresholds recommended by the JNC may contribute to reduced guideline adherence.5,64 Despite convincing data from observational studies supporting a linear association between systolic blood pressure and cardiovascular risk to levels well below current treatment thresholds,1 large, placebo-controlled trials have not been performed enrolling individuals with mild systolic hypertension (systolic blood pressure between 140 and 159 mm Hg).88 This fact may cause some physicians to have a more permissive approach toward elderly patients with isolated systolic hypertension, the largest subgroup of patients with uncontrolled hypertension.65 Concerns about increased cardiovascular risk with excessive lowering of diastolic blood pressure (J-curve phenomenon) and impairment in quality of life from antihypertensive medications may also contribute to this hesitancy, although prospective trial data have not validated these concerns.91 Yet another factor that may contribute to the burden of uncontrolled hypertension is the lack of clarity within guidelines with regard to hypertension treatment under select clinical situations. For example, Pedelty and Gorelick92 note that precise target blood pressure levels have not been delineated for stroke patients. As a result, it is not clear how soon blood pressure should be lowered after an acute stroke, the optimal rate of blood pressure lowering, and the target pressure to be attained.

Finally, despite recognizing that blood pressures are elevated, physicians may choose not to advance therapy.31,89 Phillips and colleagues89 have proposed several reasons for this clinical inertia, including overestimation of adherence to guidelines as noted above, lack of practice supports to facilitate the achievement of target blood pressures, and use of “soft” justifications to avoid advancing care for asymptomatic patients. With respect to the last point, physicians may rationalize that goals are within reach and that more time may be needed to see the effects of therapy,93 reasons that are typically without pharmacological basis.

It is also important to point out the caveats that must be considered when physician adherence to practice guidelines is evaluated. Milchak et al94 have presented a detailed methodological critique of such assessment and underscored the importance of assessing various components of hypertension care by using validated performance measures and linking measures of blood pressure control to clinical outcomes.

Quality of Hypertension Care: Impact of Select Patient-Related Factors on Quality of Care Process and Association With Poor Blood Pressure Control
Asch et al24 have recently described the correlates of optimal care of patients with hypertension using explicit indicators of the care process. They observed that the following categories of hypertensive patients were more likely to receive optimal care: those >50 years of age; patients with diabetes, coronary artery disease, or hyperlipidemia; and nonsmokers. Higher quality of care was directly associated with better blood pressure control. Additional research is warranted to better understand these patterns that seem to indicate poor care for younger hypertensives who do not have other cardiac risk factors.

Can Better Blood Pressure Control Be Achieved in Clinical Practice?
The low rates of blood pressure control in national surveys stand in contrast to the relatively high rates of control observed in randomized clinical trials.91–95,96 For instance, in the Anti-Hypertensive and Lipid-Lowering Treatment to Prevent Heart Attack (ALLHAT) trial, 55% of participants in the 3 treatment arms had blood pressure controlled <140/
TABLE 4. Future Research Directions

Defining blood pressure targets
Develop randomized controlled trials to resolve persistent controversies in hypertension management, including treatment of stage 1 isolated systolic hypertension (systolic blood pressure 140–159 mm Hg) and the choice of medications when combination antihypertensive therapy is needed.

Identify target goals for specific subgroups such as those with acute stroke, including delineating optimal time window to lower blood pressure after stroke, and rate of lowering.

Investigate the impact of nonpharmacological therapies on estimates of hypertension control rates.

Elucidate the cause of racial/ethnic differences in blood pressure control.

Establish appropriate blood pressure thresholds for making treatment decisions based on home blood pressures.

Patient-targeted interventions
Examine the clinical and financial implications of home blood pressure monitoring, including self-measurement and ambulatory blood pressure monitors, with and without telephonic transmission.

Compare different strategies to improve patient compliance (electronic medication monitors, simplified regimes, improved physician-patient communication, patient education, self-monitoring, etc).

Physician- and care process–directed
Define the role of hypertension clinics and hypertension specialists in treating uncomplicated hypertension.

Intervention studies to improve quality of care processes that are assessed via explicitly stated and validated measures of performance.

90 mm Hg at the first annual visit, and 66% of participants were at this target 4 years later. In the Controlled Onset Verapamil Investigation of Cardiovascular Endpoints (CONVINCE) study, 85% of participants were controlled at the end of the titration period, and control rates exceeded 60% throughout the trial.

Although control rates from randomized trials cannot be directly compared with those from observational studies because all participants in trials are aware of their hypertension and are under treatment, the trial data attest to the feasibility of achieving the blood pressure targets recommended by the JNC. In ALLHAT, a dramatic increase in blood pressure control was observed from the prerandomization visit (27%) to the 5-year follow-up (66%), supporting the premise that these results are largely attributable to improved treatment of hypertension rather than patient selection. It is also noteworthy that both ALLHAT and CONVINCE were conducted in a variety of practice settings and that the care was delivered predominantly by primary care physicians rather than specialists. Several factors may account for the higher rates of control in clinical trials, including guaranteed access to care, free medications, compliant patients, motivated physicians, “goal-oriented” blood pressure management, and predetermined titration algorithms. Whether any of these conditions can be replicated in actual clinical practice remains unclear.

Measures That May Improve Hypertension Control
A number of studies have examined the effect of interventions to improve patient compliance and physician adherence with hypertension guidelines. Patient-targeted interventions have emphasized educational initiatives, improved affordability of health care, pill packaging, electronic medication monitors, and formal reminders among other strategies. Most of these studies report improvements in blood pressure control, although publication bias may contribute to the predominance of favorable studies in the literature. Roter and colleagues performed a meta-analysis of studies of patient-targeted interventions for a wide range of conditions, of which hypertension was the second most common studied. They did not identify an approach that was clearly superior to others but did find that multi-tiered interventions were generally more effective than single-focus interventions. Interventions integrating multiple approaches, including better doctor-patient communication, may improve patient acceptance of therapies that might otherwise be perceived as unnecessary or prone to side effects.

There have been fewer studies of interventions specifically targeting physician practices in hypertension control. It is recognized that even high levels of patient compliance do not ensure good rates of blood pressure control because physicians may be hesitant to make medication changes. Educational initiatives may improve adherence to guidelines, although the literature on interventions to improve physician practice indicates that education alone is not sufficient. Prior studies have demonstrated success with more “active” measures such as computer-generated reminders and provision of feedback. The inclusion of hypertension control as a quality of care measure in HEDIS is a form of feedback that may have contributed to increased control rates in participating health plans between 2000 and 2003. Finally, an extreme measure to overcome clinical inertia is “forced titration” of hypertensive medications when blood pressures are not at goal, an approach used in many clinical trials. Although this practice appears effective, it would be difficult to implement in community practices.

Recently, attention has been focused on how care is delivered to hypertensive patients, including the types of providers and specific disease management programs. In 1998, the American Society of Hypertension created the designation “specialist in clinical hypertension,” which is currently held by 700 physicians in the United States. Several studies have suggested that high rates of control can be achieved in referral clinics staffed by hypertension specialists, even among patients felt to have difficult-to-treat hypertension. Other studies have emphasized that nonphysician providers such as nurses, nurse practitioners, and pharmacists can play a critical role in improving the quality of hypertension care. Indeed, it has been proposed that the lack of a multidisciplinary approach is an important reason that the hypertension control rates achieved in randomized trials have not been replicated in actual practice. Nurse-led clinics may be particularly helpful for treating patients with hypertension and comorbidities such as coronary heart disease or diabetes; advantages of such clinics include the ability to accommodate more frequent patient visits, a greater willingness to titrate medications, and attention to lifestyle measures. A potential adjunct to multidisciplinary programs is to involve patients in the monitoring of medication changes by self-measurement of blood pressure or transmission of blood pressure data over...
telephone lines, although the economic and clinical implications of home blood pressure measurement are not well established.

Future Research Directions

Studies of the epidemiology of uncontrolled hypertension have provided both cause for concern and reason for optimism. The concern stems from the finding in national surveys that up to two thirds of adults with hypertension in this country are inadequately treated. This represents a major missed opportunity for cardiovascular disease prevention, given the importance of hypertension as a risk factor for stroke, coronary heart disease, and heart failure. It has been estimated that a third to a half of coronary heart disease events could be prevented with optimal control of blood pressure at the population level. If improved control rates are not attained, the medical and financial burden of these excess events would grow substantially in the next several decades because of the aging of the population and the high prevalence of hypertension in the elderly.

However, there may also be reason for optimism. Although increases in hypertension control have fallen short of goals, most longitudinal studies suggest that gains have been made in the past several decades. National data show that individuals with hypertension have access to health care and see physicians regularly, meaning that opportunities for intervention continue to exist. Additionally, the experience reported from randomized trials and hypertension clinics demonstrates that high rates of control are achievable with currently available therapies.

The Healthy People 2010 report targets a control rate of 50% in 5 years, which would be reached if at least 80% of hypertensive individuals were aware of their condition, 90% were treated, and 70% of those treated were controlled. Recent NHANES data indicate that improvements are needed in all 3 areas, suggesting that multi-pronged approaches are required to increase both patient awareness and patient and physician adherence to treatment guidelines. One foundation for these interventions is further research to address several of the unanswered questions in hypertension care and control (Table 4). Studies of the past 20 years have led to a greater recognition that the pioneering advances from clinical trials are not being adequately translated into clinical practice. A concerted, multidisciplinary effort is needed to ensure that the benefits of this research are fully realized in future decades.

Acknowledgment

This work was supported by NIH/NHLBI NO1-HC-25195, K23 HL-074077 (Dr Wang), and K24-HL-04334 (Dr Vasan).

Disclosure

Dr Wang has received financial compensation from Novartis, Inc, for contributing to an electronic textbook.

References


**Key Words:** epidemiology ■ hypertension ■ risk factors
Epidemiology of Uncontrolled Hypertension in the United States
Thomas J. Wang and Ramachandran S. Vasan

Circulation. 2005;112:1651-1662
doi: 10.1161/CIRCULATIONAHA.104.490599
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2005 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/112/11/1651

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org//subscriptions/