Uncontrolled and Apparent Treatment Resistant Hypertension in the United States, 1988 to 2008

Brent M. Egan, MD; Yumin Zhao, PhD; R. Neal Axon, MD;
Walter A. Brzezinski, MD; Keith C. Ferdinand, MD

Background—Despite progress, many hypertensive patients remain uncontrolled. Defining characteristics of uncontrolled hypertensives may facilitate efforts to improve blood pressure control.

Methods and Results—Subjects included 13 375 hypertensive adults from National Health and Nutrition Examination Surveys (NHANESs) subdivided into 1988 to 1994, 1999 to 2004, and 2005 to 2008. Uncontrolled hypertension was defined as blood pressure ≥140/≥90 mm Hg and apparent treatment-resistant hypertension (aTRH) when subjects reported taking ≥3 antihypertensive medications. Framingham 10-year coronary risk was calculated. Multivariable logistic regression was used to identify clinical characteristics associated with untreated, treated uncontrolled on 1 to 2 blood pressure medications, and aTRH across all 3 survey periods. More than half of uncontrolled hypertensives were untreated across surveys, including 52.2% in 2005 to 2008. Clinical factors linked with untreated hypertension included male sex, infrequent healthcare visits (0 to 1 per year), body mass index <25 kg/m^2, absence of chronic kidney disease, and Framingham 10-year coronary risk <10% ($P<0.01$). Most treated uncontrolled patients reported taking 1 to 2 blood pressure medications, a proxy for therapeutic inertia. This group was older, had higher Framingham 10-year coronary risk than patients controlled on 1 to 2 medications ($P<0.01$), and comprised 34.4% of all uncontrolled and 72.0% of treated uncontrolled patients in 2005 to 2008. We found that aTRH increased from 15.9% (1998–2004) to 28.0% (2005–2008) of treated patients ($P<0.001$). Clinical characteristics associated with aTRH included ≥4 visits per year, obesity, chronic kidney disease, and Framingham 10-year coronary risk >20% ($P<0.01$).

Conclusion—Untreated, undertreated, and aTRH patients have consistent characteristics that could inform strategies to improve blood pressure control by decreasing untreated hypertension, reducing therapeutic inertia in undertreated patients, and enhancing therapeutic efficiency in aTRH. **(*Circulation*. 2011;124:1046-1058.)**

Key Words: epidemiology ■ hypertension ■ population ■ race/ethnicity

Blood pressure (BP) control to <140/<90 mm Hg among a representative sample of hypertensive patients participating in the National Health and Nutrition Examination Surveys (NHANESs) improved from 27.3% in 1988 to 1994 to 50.1% in 2007 to 2008.[1,2] On the basis of NHANES 2007 to 2008 hypertension prevalence data and estimates of the US population ≥18 years of age in 2008, there are ≈67.5 million hypertensive adults in the United States, with >33 million uncontrolled.[2,3] Approximately 13 of the 33 million uncontrolled hypertensive patients are unaware and 20 million aware of their hypertension.

Clinical Perspective on p 1058

Data from NHANES 1988 to 2008 document that the majority of uncontrolled hypertensive patients remain untreated.[2] Other evidence suggests that therapeutic inertia, ie, the failure to uptitrate or to add antihypertensive medications when BP is uncontrolled, is a significant contributor to uncontrolled hypertension.[4–6] Moreover, the prevalence of treatment-resistant hypertension, ie, BP uncontrolled on a rational regimen including ≥3 or controlled on ≥4 antihypertensive medications, appears to be increasing. This may reflect the effects of an aging population with more obesity and related comorbidities, eg, diabetes mellitus and chronic kidney disease (CKD).[7]

Defining the clinical characteristics of hypertensive patients with untreated, inadequately treated, and treatment-resistant hypertension could inform strategies and interventions for improving BP management. Therefore, the NHANESs 1988 to 2008 were analyzed. Although

Continuing medical education (CME) credit is available for this article. Go to http://cme.ahajournals.org to take the quiz.
Received March 7, 2011; accepted June 29, 2011.

From the Department of Medicine, Division of General Internal Medicine and Geriatrics, Medical University of South Carolina, Charleston (B.M.E., Y.Z., R.N.A., W.A.B.); Center for Disease Prevention and Health Interventions for Diverse Populations, Ralph H. Johnson Veterans Affairs Medical Center, Charleston, SC (R.N.A.); and Department of Medicine, Division of Cardiology, Emory University, Atlanta, GA (K.C.F.).

Correspondence to Brent M. Egan, MD, Medical University of South Carolina, 135 Rutledge Ave, 1230 RT, Charleston, SC 29425. E-mail eganbm@musc.edu

Circulation **is available at http://circ.ahajournals.org** **DOI: 10.1161/CIRCULATIONAHA.111.030189**

medication dose and adherence and BP measurement artifacts are also significant factors in defining inadequately treated and treatment-resistant hypertension,[7] NHANES does not capture these variables. Thus, the term apparent treatment-resistant hypertension (aTRH) is applied.

Methods

As described previously,[2] NHANESs 1988 to 1994 and 1999 to 2008 were conducted by the Centers for Disease Control and Prevention National Center for Health Statistics (NCHS). Through the use of stratified, multistage probability sampling of the noninstitutionalized US population, NHANES volunteers were selected. All adults provided written informed consent approved by the NCHS Institutional/Ethics Review Board.[8,9]

Race/Ethnicity and BP Measurement

Race/ethnicity was determined by self-report and separated into non-Hispanic white (white), non-Hispanic black (black), and Hispanic ethnicity of any race as described.[1,2,10] Although other race data were obtained (American Indian, Alaskan Native, Asian or Pacific Islander, and other race not specified), the number of individuals was insufficient for meaningful analyses.[2]

The BP measurement methods were consistent across 1988 to 1994 and 1999 to 2008.[2] In brief, BP was measured by trained physicians using a mercury sphygmomanometer and appropriately sized arm cuff on subjects after 5 minutes of seated rest. Individuals without recorded BP were excluded. In the determination of mean systolic and diastolic BPs for individuals, the first BP value was used if only 1 measurement was obtained. The second BP was used if 2 readings were taken; the second and third values were averaged when available. More than 90% of subjects had ≥2 BP measurements in all survey periods.[2]

Hypertension

Hypertension was defined as mean systolic BP ≥140 mm Hg and/or mean diastolic BP ≥90 mm Hg and/or a positive response to the question "Are you currently taking medication to lower your BP?"[1,2,10] Awareness of hypertension was determined by hypertensive patients responding affirmatively to the question, "Have you ever been told by a doctor or other healthcare professional that you had hypertension, also called high blood pressure?"[1,2,10] Treatment of hypertension was established by participants responding "yes" to the question, "Because of your hypertension/high blood pressure, are you now taking prescribed medicine?"[1,2,10]

Control of hypertension was defined as BP <140/<90 mm Hg across all survey periods, although the BP goals for high-risk subgroups, including diabetics, were lower for 1999 to 2008.[11–14] Recent evidence does not clearly support a goal systolic BP <140 mm Hg for diabetic patients or those with nonproteinuric hypertensive renal disease.[15,16] For these reasons and to facilitate comparisons across study, this report focuses exclusively on goal BP <140/<90 mm Hg.

Concomitant risk factors, including diabetes mellitus and cigarette smoking, were defined as described.[2] Definitions for cardiovascular disease, including stroke and coronary heart disease (CHD), were described.[2] We defined CKD as an estimated glomerular filtration rate <60 $mL \cdot m^{-2} \cdot min^{-1}$ and/or urine albumin:creatinine ≥300 mg/g.[17,18] Serum creatinine values were adjusted to facilitate comparisons of estimated glomerular filtration rate across surveys.[19]

Diabetes Mellitus

Diabetes mellitus was defined by a positive response to the questions, "Have you ever been told by a doctor that you have diabetes?" and/or "Are you now taking insulin?" and/or "Are you now taking diabetes pills to lower your blood sugar?" The definition did not include patients with only fasting plasma glucose ≥126 mg/dL, ie, "undiagnosed diabetes mellitus."[20,21]

Low-Density Lipoprotein Cholesterol and Framingham CHD Risk

Low-density lipoprotein cholesterol, calculated with the Friedewald equation,[22] was obtained from the NHANES data set for the 3 time periods. The Framingham 10-year CHD risk was calculated.[22]

Medical Visits

The number of medical visits in the past year was assessed by the question, "How many times did you receive health care over the last year"? The responses were grouped into 3 categories: 0 to 1, 2 to 3, and ≥4 healthcare visits a year.

Insurance Status and Therapeutic Inertia

Insurance status is determined by a yes/no answer to the question, "Are you covered by health insurance or some other kind of healthcare plan?"

Therapeutic inertia was calculated for uncontrolled patients who reported ≥2 healthcare visits per year. Uncontrolled patients reporting 0 to 1 visits annually were excluded because infrequent care provides little opportunity to intensify treatment. Therapeutic inertia was arbitrarily defined as high, moderate, low, and none on the basis of the number of antihypertensive medications reported, BP, and 10-year Framingham CHD risk.

High-level therapeutic inertia included patients on 0 to 1 antihypertensive medications with BP ≥160/≥100 mm Hg regardless of 10-year CHD risk, ≥150/≥95 and <160/<100 mm Hg with 10-year CHD risk 10% to 20% and >20%, and ≥140/≥90 and <150/<95 mm Hg with 10-year CHD risk ≥20%.

Moderate-level therapeutic inertia included patients on 2 medications with BP ≥160/≥100 mm Hg regardless of 10-year CHD risk, ≥150/≥95 and <160/<100 mm Hg with 10-year CHD risk 10% to 20% and >20%, and ≥140/≥90 and <150/<95 mm Hg with 10-year CHD risk ≥20%, as well as patients on 0 to 1 medications with BP ≥150/≥95 and <160/<100 mm Hg with 10-year CHD risk <10% or ≥140/≥90 and <150/<95 mm Hg with 10-year CHD risk 10% to 20%.

Low-level therapeutic inertia included patients on 2 meds with BP ≥150/≥95 and <160/<100 mm Hg with 10-year CHD risk <10% and ≥140/≥90 and <150/<95 mm Hg with 10-year CHD risk 10% to 20%, as well as patients with BP ≥140/≥90 and <150/<95 mm Hg on 0 to 1 medications and 10-year risk <10%. No therapeutic inertia included patients with BP ≥140/≥90 and <150/<95 mm Hg on 2 medications and 10-year risk <10% and all uncontrolled patients on ≥3 BP medications.

Antihypertensive Medications

Participants were asked if they had taken any prescription medications in the past month. During the household surveys in 1999 to 2004 and 2005 to 2008, participants were requested to provide prescription containers, and 88.8% and 88.3%, respectively, did so. Each medication identified from medications provided or described was recorded and matched to a prescription drug database. Each medication identified was assigned its generic equivalent. Antihypertensive medications were classified into a single category according to the seventh report of the Joint National Committee on Hypertension with the addition of proprietary medications not marketed when the document was published.[14] Single-pill combinations were separated into their generic components. Each medication was classified into only 1 category. The sum of BP medication categories defined the number of antihypertensive medications taken by each patient.

Data Analysis

The NHANES Analytic and Reporting Guidelines were followed.[23] SAS callable SUDAAN version 9.0.1 (SAS Institute Inc, Cary, NC) was used for all analyses to account for the complex NHANES sampling design. Standard errors were estimated with Taylor series

Table 1. Characteristics of Uncontrolled and Controlled Individuals With Hypertension in 3 National Health and Nutrition Examination Survey Time Periods

	1988–1994		1999–2004		2005–2008	
	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled
n (%) [95% CI]	3841 (73.2) [71.3–74.9]	1220 (26.8) [25.1–28.7]	3170 (64.2) [61.9–66.4]	1589 (35.8) [33.6–38.1]	1907 (52.5) [50.0–55.0]	1648 (47.5) [45.0–50.0]
Age, y	59.0 (58.0–60.0)	60.1 (58.6–61.5)	58.9 (57.9–59.9)	59.0 (58.2–59.9)	58.3 (56.9–59.7)	59.7 (58.4–61.1)
Sex, % male	51.8 (48.8–54.8)†‡	38.3 (34.5–42.8)§	46.3 (44.1–48.5)‡	47.9 (44.5–51.3)	50.6 (48.5–52.7)*	45.3 (42.7–48.0)‡
Race						
White	75.8 (72.6–73.8)†	81.2 (78.0–30.3)	72.5 (68.0–76.6)*	77.5 (73.3–81.2)	71.3 (65.1–76.7)†	77.3 (72.3–81.6)
Black	14.9 (13.0–17.0)	13.1 (11.4–27.3)	13.8 (10.8–17.4)	12.8 (10.3–15.9)	15.2 (11.4–20.0)	13.1 (9.8–17.4)
Hispanic	3.8 (3.3–4.5)‡	2.0 (1.6–2.5)‡	9.9 (6.8–14.1)	7.3 (4.8–10.8)	8.9 (6.6–11.9)§	5.9 (4.4–7.9)§
SBP, mm Hg	150.6 (149.6–151.6)†	122.4 (121.3–123.5)	151.8 (151.0–152.7)†	122.3 (121.6–123.0)	150.5 (149.5–151.6)†	121.0 (120.3–121.7)
DBP, mm Hg	83.2 (82.4–84.0)†§	72.7 (71.8–73.6)§	80.2 (79.2–81.3)†	70.1 (69.3–70.9)‡	79.7 (78.8–80.6)†§	68.4 (67.4–69.5)§
Take BP medications, %	36.3 (34.1–52.5)†	100	39.8 (37.2–42.4)†	100	43.6 (40.5–46.8)†§	100
BP medications (on BP medications), n	1.68 (1.62–1.75)	1.71 (1.65–1.77)	1.84 (1.78–1.90)	1.89 (1.82–1.96)	2.01 (1.91–2.10)	1.97 (1.88–2.05)
Visits per year						
0–1	35.7 (33.3–38.2)†§	12.3 (9.7–15.6)	28.1 (25.9–30.4)†	9.2 (7.3–11.5)	29.8 (26.7–33.1)†‡	9.2 (7.0–12.0)
2–3	24.5 (22.5–26.6)	28.1 (24.6–31.9)	27.8 (25.7–30.1)	26.0 (23.2–28.9)	25.6 (23.3–28.1)	26.8 (25.0–28.7)
≥4	39.8 (37.3–42.3)‡	59.6 (55.2–63.8)	44.1 (41.5–46.7)	64.8 (61.6–68.0)	44.6 (41.9–47.4)‡	64.0 (61.0–67.0)
Uninsured, %	7.4 (6.0–9.1)§	6.7 (4.6–9.5)	12.1 (10.5–14.0)†	5.2 (4.0–6.7)	14.7 (12.4–17.2)†§	7.0 (5.3–9.1)
BMI, kg/m^2	28.7 (28.3–29.1)*‡	29.8 (29.0–30.7)	29.5 (29.1–29.8)†	31.0 (30.6–31.5)	30.0 (29.6–30.5)*§	31.2 (30.8–31.6)‡
<25 kg/m^2, %	29.6 (27.5–31.8)*§	20.9 (17.8–24.3)	24.1 (22.1–26.1)†	16.1 (13.7–18.9)	24.4 (21.6–27.4)*‡	17.4 (15.0–19.9)
>30 kg/m^2, %	34.9 (32.1–37.9)‡	41.2 (35.4–47.3)‡	39.7 (37.0–42.4)	49.9 (46.7–53.0)	41.5 (38.8–44.2)§	51.2 (48.6–53.7)‡
LDL-C, mg/dL	139.5 (136.8–142.2)§	138.7 (135.5–141.9)§	125.6 (123.5–127.6)*§	117.3 (113.2–121.3)‡	118.6 (115.9–121.3)‡§	107.4 (104.1–110.6)§
Diabetes mellitus, %	10.5 (9.5–11.5)	15.7 (12.3–19.9)	11.7 (10.7–12.8)†§	20.1 (17.9–22.5)	16.0 (13.8–18.6)*§	21.3 (19.1–23.7)
Current smoker, %	20.2 (18.1–22.5)‡	17.6 (15.0–20.6)	16.9 (15.4–18.5)‡	17.9 (15.4–20.8)	21.5 (18.9–24.3)	16.2 (13.6–19.2)
CKD, %	12.9 (11.3–14.7)	14.9 (12.8–17.2)	14.6 (13.2–16.0)	16.9 (14.9–19.1)	14.4 (11.9–17.2)	15.9 (13.7–18.4)
CVD, %	15.9 (14.1–18.0)†	23.0 (19.4–27.0)	14.2 (12.6, 15.8)*	21.2 (18.5–24.1)	15.6 (13.9–17.6)	20.6 (17.3–24.3)
10-y FCR >20%	33.2 (31.1–35.3)†	41.4 (37.1–45.8)	30.0 (28.1–31.9)†	39.4 (36.4–42.5)	34.3 (30.8–37.9)	38.4 (35.2–41.7)
10-y FCR 10–20%	24.0 (22.6–25.6)‡	20.1 (16.7–24.0)	21.0 (19.1–23.0)	22.2 (20.1–24.4)	21.9 (19.6–24.3)	19.7 (17.0–22.8)
10-y FCR <10%	42.8 (40.5–45.1)§	38.4 (33.7–43.4)	49.1 (46.8–51.4)‡	38.4 (35.5–41.3)	43.9 (40.1–47.7)	41.9 (38.8–45.1)

CI indicates confidence interval; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; LDL-C low-density lipoprotein cholesterol; CKD, chronic kidney disease; CVD, cardiovascular disease; and FCR, Framingham coronary heart disease risk.

*<0.01, †<0.001 denote differences between uncontrolled and controlled groups within the same National Health and Nutrition Examination Survey (NHANES) time period. The within-period differences for race/ethnicity, visit frequency, obese versus lean BMI, and 10-y FCR apply to the group. ‡<0.01, §<0.001 denote differences between NHANES time periods within the controlled or uncontrolled groups. Symbols in 1988 to 1994 denote differences with 1999 to 2004; symbols in 1999 to 2004 denote differences with 2005 to 2008; and symbols in 2005 to 2008 indicate differences with 1988 to 1994.

linearization. All NHANES periods were age adjusted to the US 2000 Census data as described.[2]

To test for significant differences in variables between/among groups within each survey, the χ^2 test in the CROSSTAB procedure was used for categorical variables, the WALD F test in the REGRESS was used for continuous variables, and LOGLINK was used for medications. When >2 groups were compared within an NHANES survey period, analysis was limited to assessing differences across the groups and not between pairs. Pairwise comparisons between the 3 NHANES periods were conducted with *t* tests of weighted means[1] between pairs of the 3 groups matched for medication number. The effects of time were not assessed before pairwise comparisons because SUDAAN would not allow this function when only 3 time periods were analyzed. Because multiple statistical comparisons were performed within and between the 3 NHANES time periods, 2-sided values of $P<0.01$ were accepted as statistically significant.

Odds ratios and 95% confidence intervals were calculated to assess the relationship of selected independent clinical covariables to 3 dependent variables: untreated uncontrolled hypertension, uncontrolled hypertension treated with 1 to 2 BP medications, and uncontrolled aTRH treated with ≥3 BP medications. Univariable and fully adjusted multivariable logistic regressions were performed with RLOGIST.

Results

Uncontrolled and Controlled Hypertensive Patients

The proportion of patients with uncontrolled hypertension declined from 73.2% in 1988 to 1994 to 52.5% in 2005 to 2008 (Table 1). Men were more likely than women to have uncontrolled hypertension in 1988 to 1994 and 2005 to 2008. Across surveys, a lower proportion of whites and a higher proportion of blacks and Hispanics of any race were represented among uncontrolled patients. As expected, systolic and diastolic BP values were lower in controlled than uncontrolled patients. Systolic BP did not change over time in either group, whereas diastolic BP declined in both.

The number of BP medications increased over time in both treated uncontrolled and controlled patients but did not differ

between groups. Uncontrolled patients were more likely to report 0 to 1 healthcare visits annually, whereas controlled patients were more likely to report ≥4 annual visits. The proportion of uninsured patients did not change in controlled hypertensives but increased in uncontrolled patients over time. Body mass index rose over time in both groups and was higher in controlled patients. Low-density lipoprotein cholesterol declined over time in both groups and was lower in controlled patients in 1999 to 2004 and 2005 to 2008. The prevalence of diabetes mellitus increased over time and was more common in controlled than uncontrolled patients. The percentage of current cigarette smokers did not differ between controlled and uncontrolled hypertensives but was lower among uncontrolled patients in 1999 to 2004 than the other 2 time periods.

The percentage of hypertensive patients with CKD did not change significantly with time and was not different in uncontrolled and controlled patients. Prevalent clinical cardiovascular disease was more common in controlled than uncontrolled patients in 1988 to 1994 and 1999 to 2004 but did not change with time. Framingham 10-year CHD risk was higher in controlled than uncontrolled patients in 1988 to 1994 and 1999 to 2004.

Number of Antihypertensive Medications

The percentage of all hypertensive individuals who were untreated declined, whereas the percentages on 2 and ≥3 BP medications increased over time (Figure 1A). Among all uncontrolled patients, the percentage of untreated subjects declined with time, but the mean remained >50% in 2005 to 2008 (52.2%; 95% confidence interval, 48.1 to 56.3; Figure 1B). The percentage of treated uncontrolled patients on 1 medication fell whereas the percentage on ≥3 medications rose with time (Figure 1C). Among treated uncontrolled (Figure 1C) and treated controlled (Figure 1D) hypertensive patients, the number of BP medications reported and changes over time were similar. The proportion on 1 BP medication fell and the proportion on ≥3 BP medications rose. All controlled hypertensives reported taking BP medications. However, ≈4% to 5% of them did not bring any antihypertensive medications to the examination, nor did they identify any BP medications during the interview, including "unspecified" (Figure 1D).

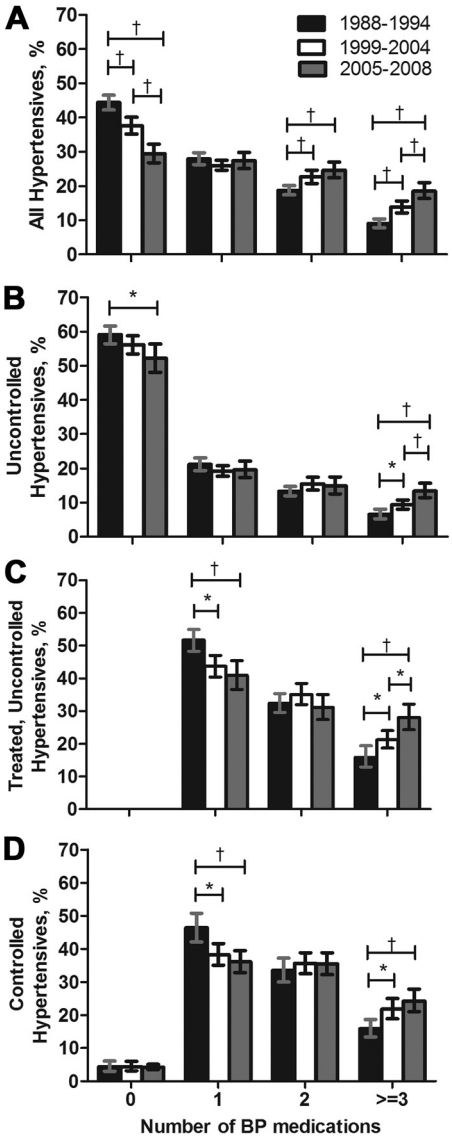

Figure 1. The percentages of hypertensive patients who reported taking 0, 1, 2, and ≥3 antihypertensive (blood pressure [BP]) medications for (**A**) all, (**B**) all uncontrolled, (**C**) treated uncontrolled, and (**D**) treated controlled patients in the different National Health and Nutrition Examination Survey (NHANESs). Symbols over a trio of columns indicate significant changes in the percentage of patients reportedly taking a given number of antihypertensive medications across the 3 NHANES time periods. *$P<0.01$; †$P<0.001$.

Uncontrolled Hypertensive Patients Grouped by Number of Antihypertensive Medications

The proportion of untreated patients fell between 1988 to 1994 and 2005 to 2008, whereas the percentage on 1 to 2 medications did not change and the percentage on ≥3 medications rose (Table 2). The proportion of uncontrolled hypertensive patients who were uninsured increased with time. Systolic BP was lower and diastolic BP was higher in untreated than treated patients. Untreated hypertensive patients were younger and more likely to be men, infrequent healthcare users, and uninsured and to have 10-year CHD risk <10% than treated patients. Conversely, untreated patients were less likely to have ≥4 healthcare visits annually, stage 2 hypertension, diabetes mellitus, CKD, and 10-year CHD risk >20% than treated patients, especially those on ≥3 BP medications, ie, aTRH.

Controlled Hypertensive Patients Grouped by Number of Antihypertensive Medications

In general, there were more differences by number of medications within uncontrolled than within controlled hypertensive patients (Table 3). Whereas all controlled hypertensive patients reported taking BP medication, 4% to 5% across all survey periods did not verbally identify or physically bring any of them during their assessment. Untreated hypertensive patients were younger than those on ≥3 medications.

Table 2. Characteristics of Uncontrolled Hypertensive Patients Grouped by Number of Antihypertensive Medications Reportedly Taken

	1988–1994			1999–2004			2005–2008		
	0 Medications	1–2 Medications	≥3 Medications	0 Medications	1–2 Medications	≥3 Medications	0 Medications	1–2 Medications	≥3 Medications
n (%) [95% CI]	2236 (59.0) [56.4–61.6]	1353 (34.4) [32.1–36.9]	252 (6.5) [5.2–8.1]‡	1648 (56.1) [53.4–58.8]	1200 (34.6) [32.3–36.9]	322 (9.3) [8.1–10.7]§	921 (52.2) [48.1–56.3]‡	688 (34.4) [30.9–38.0]	298 (13.4) [11.4–15.7]§
Percent of treated		84.1 (80.5–87.1)‡	15.9 (12.9–19.4)‡		78.8 (76.0–81.3)‡	21.2 (18.7–24.0)‡		72.0 (68.0–75.7	28.0 (24.3–32.1)§
Age, y	54.9 (53.9–55.9)	64.6 (63.3–66)	66.1 (63.2–68.9)†	54.1 (52.7–55.6)	64.7 (63.6–65.7)	66.0 (64.2–67.9)†	51.8 (50.4–53.2)	64.7 (63.6–65.8)	67.2 (65.0–69.3)†
Sex, % male	59.4 (55.5–63.2)‡	41.0 (37.3–44.8)	39.8 (31.8–48.3)†	52.8 (49.9–55.7)‡	38.3 (34.7–42)	36.3 (30.3–42.8)†	58.7 (54.7–62.5)	42.5 (38.1–47.1)	39.8 (33.4–46.6)†
Race									
White	74.5 (71.3–77.4)	77.2 (72.5–81.3)	80.9 (75.4–85.5)†	71.3 (66.4–75.8)	74.2 (69.1–78.7)	73.3 (66.7–79.0)†	67.7 (60.3–74.3)	77.4 (69.6–83.6)	69.6 (61.3–76.7)*
Black	14.8 (13.0–16.8)	14.8 (12.1–18.0)	15.4 (11.7–20.1)	13.1 (10.2–16.6)	13.9 (10.6–18.1)	17.4 (13.0–23.0)	14.8 (10.8–19.9)	13.5 (8.9–19.9)	21.5 (15.9–28.4)
Hispanic	4.6 (4.0–5.4)§	2.7 (2.1–3.6)‡	2.4 (1.4–4.1)	11.8 (8.5–16.3)	7.7 (4.9–11.9)	6.0 (3.1–11.4)	11.7 (8.8–15.5)§	6.4 (4.4–9.3)†	4.1 (2.1–7.9)
0–1 Visits per year	51.4 (48.1–54.6)§	13.9 (11.2–17.1)	9.2 (5.1–16.2)†	42.1 (39.1–45.2)	10.4 (8.1–13.2)	9.5 (5.7–15.5)†	47.5 (43.1–52)	12.7 (10.2–15.8)	4.4 (2.0–9.0)†
≥4 Visits per year	27.3 (24.9–29.8)	56.8 (51.8–61.7)	63.2 (55.9–69.9)	30.7 (28.2–33.3)	58.4 (54.4–62.2)	71.5 (63.3–78.5)	27.2 (24.2–30.5)	59.1 (54.9–63.1)	75.0 (69.1–80.2)‡
Uninsured, %	10.2 (8.1–12.8)§	3.8 (2.5–5.7)‡	1.1 (0.4–3.3)†	16.3 (13.4–19.5)‡	7.5 (5.7–9.7)	4.6 (2.3–9.1)†	22.8 (18.8–27.4)§	6.5 (4.1–10)	4.0 (2.1–7.3)†
SBP, mm Hg	147.7 (146.6–148.8)	154.6 (153.1–156.1)	155.8 (152.9–158.8)†	148.9 (147.9–149.9)	155.4 (153.8–157)§	156.5 (154.3–158.6)†	147.7 (146.5–149.0)	152.0 (150.8–153.1)‡	157.8 (155.9–159.6)†
DBP, mm Hg	85.1 (84.1–86.0)	80.9 (79.7–82.1)§	78.6 (76.0–81.3)†	83.2 (82.1–84.4)	76.9 (75.4–78.3)	74.5 (72.4–76.5)†	83.0 (81.7–84.3)‡	76.9 (75.5–78.3)§	73.9 (72.0–75.8)†‡
BP ≥ 160/ ≥ 100 mm Hg	23.2 (20.7–26.0)	35.7 (32.2–39.3)	34.0 (26.2–42.7)†	25.3 (22.8–27.9)	35.5 (31.0–40.2)§	37.0 (31.8–42.5)†	20.8 (17.4–24.6)	24.9 (21.0–29.3)§	41.8 (37.1–46.6)†
BMI, kg/m^2	28.2 (27.8–28.7)	29.2 (28.6–29.7)	29.9 (28.6–31.2)*	28.9 (28.4–29.4)	29.9 (29.4–30.4)	31.4 (30.2–32.6)	29.5 (28.8–30.1)‡	30.0 (29.4–30.7)	32.3 (31.1–33.6)*‡
Diabetes mellitus, %	5.8 (4.8–7.0)	16.4 (14.3–8.8)	21.3 (15.2–28.9)†	5.9 (4.8–7.2)	17.0 (14.9–19.4)‡	27.5 (21.7–34.1)†‡	6.6 (4.9–8.8)	21.5 (18.6–24.6)‡	39.0 (31.9–46.6)†§
CKD, %	6.2 (5.1–7.6)	19.3 (16.9–21.9)	40.1 (31.1–49.7)†	7.7 (6.2–9.4)	19.9 (17.1–23.1)	36.1 (30.3–42.4)†	6.1 (4.3–8.4)	17.7 (14.1–21.9)	37.8 (30.4–45.7)†
FCR >20%, %	17.5 (15.5–19.7)§	53.5 (49.9–57.2)	67.6 (59.5–74.7)†	12.6 (11.0–14.5)	48.5 (44.8–52.3)	65.5 (58.3–72.1)†	14.7 (11.6–18.6)	49.8 (45.3–54.3)	70.7 (62.1–78.1)†
FCR <10%, %	58.0 (55.1–60.8)§	22.3 (18.9–26.1)‡	13.6 (8.5–21.1)	67.2 (64.5–69.9)	28.3 (25–31.8)	16.8 (11.7–23.4)	65.6 (60.6–70.2)‡	23.0 (18.8–27.8)	12.7 (7.7–20.2)

CI indicates confidence interval; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; CKD, chronic kidney disease; and FCR, Framingham 10-year coronary heart disease risk.

*<0.01, †<0.001 between groups within NHANES time period. ‡<0.01, §<0.001 across National Health and Nutrition Examination Survey time periods within the uncontrolled hypertensive groups on 1, 2, and ≥3 medications. To designate differences between time periods, symbols within 1988 to 1994 denote differences with 1999 to 2004, symbols within 1999 to 2004 denote differences with 2005 to 2008, and symbols within 2005 to 2008 indicate differences with 1988 to 1994.

Table 3. Characteristics of Controlled Hypertensive Patients Grouped by Number of Antihypertensive Medications Reportedly Taken

	1988–1994			1999–2004			2005–2008		
	0 Medications	1–2 Medications	≥3 Medications	0 Medications	1–2 Medications	≥3 Medications	0 Medications	1–2 Medications	≥3 Medications
n (%) [95% CI]	70 (4.3) [3.0–6.0]	955 (79.9) [77.0–82.6]‡	195 (15.8) [13.4–18.6]	80 (4.3) [3.1–6.0]	1126 (73.9) [70.3–77.2]	383 (21.8) [18.9–25]	79 (4.2) [3.5–5.1]	1115 (71.5) [68.1–74.7]§	454 (24.3) [21–27.8]§
Age, y	59.4 (55.1–63.6)	59.6 (58.2–61.0)	62.4 (59.5–65.4)	57.5 (53.5–61.6)	57.7 (56.7–58.7)	63.9 (62.4–65.3)†	54.9 (51.3–58.4)	58.1 (56.7–59.5)	65.3 (63.7–67)†
Sex, % male	26.0 (15.4–40.5)	39.9 (35.6–44.4)‡	33.3 (24.9–43)‡	43.9 (29.8–59.0)	48.5 (44.2–52.9)	46.6 (40.6–52.7)	60.0 (43.1–74.9)§	44.4 (40.8–48.1)	45.5 (40.2–50.9)
Race									
White	73.2 (53.6–86.5)	81.8 (78.1–84.9)	80.7 (75.1–85.3)*	57.8 (38.9–74.7)	79.7 (75.5–83.3)	73.8 (67.2–79.5)	68.4 (53.0–80.7)	77.6 (72.6–81.9)	78.0 (71.6–83.3)
Black	18.4 (10.8–29.6)	12.3 (10.7–14.1)	15.7 (11.6–20.8)	17.5 (10.5–27.7)	11.5 (9.1–14.4)	16.4 (12.1–21.9)	13.6 (6.6–26.0)	12.3 (9.1–16.5)	15.6 (11.0–21.6)
Hispanic	4.0 (2.0–7.5)	2.1 (1.7–2.7)§	0.8 (0.4–1.8)‡	23.0 (8.6–48.7)	6.2 (4.2–9.0)	7.7 (4.2–13.6)	13.9 (8.3–22.2)‡	6.1 (4.4–8.4)§	3.9 (2.5–6.1)§
0–1 Visits per year	23.6 (12.8–39.4)	11.6 (8.7–15.2)	13.0 (8.2–20.1)	12.0 (5.7–23.7)	9.8 (7.7–12.5)	6.4 (3.5–11.3)	12.3 (8.1–18.3)	9.8 (7.0–13.4)	6.9 (4.2–11.0)
≥4 Visits per year	35.8 (25.5–47.7)§	60.6 (55.9–65.1)	60.6 (50.2–70)	71.1 (56.1–82.6)	63.0 (59.3–66.6)	69.9 (63.4–75.6)†	55.6 (44.3–66.3)‡	62.1 (58.3–65.7)	71.2 (64.6–77.1)
Uninsured, %	8.1 (2.7–21.8)	6.4 (4.3–9.5)	7.4 (2.3–21.8)	7.6 (3.2–16.8)	6.0 (4.5–7.9)	2.0 (0.9–4.5)	20.4 (9.1–39.6)	6.9 (5.1–9.4)	4.8 (3.1–7.4)
SBP, mm Hg	119.6 (115.6–123.6)	122.2 (121.0, 123.5)	124.1 (121.9, 126.4)	124.3 (121.6, 127.1)	122.1 (121.3–122.9)	122.6 (121.7–123.5)‡	122.2 (119.2–125.2)	121.2 (120.4–122.1)	120.0 (118.4–121.6)‡
DBP, mm Hg	73.2 (70.4–76.0)	72.6 (71.7–73.6)	72.8 (71.0–74.5)§	69.7 (65.3–74)	71.1 (70.1–72.0)	66.9 (65.8–68.0)	70.9 (66.2–75.5)	69.4 (68.4–70.5)§	64.9 (63.6–66.3)†§
BMI, kg/m^2	33.0 (23.4–42.6)	29.4 (28.7–30.0)§	31.3 (29.2–33.3)	30.9 (28.7–33.1)	30.7 (30.2–31.1)	32.2 (31.2–33.2)	30.7 (28.8–32.5)	31.0 (30.6–31.5)§	31.8 (31.0–32.6)
Diabetes mellitus, %	13.5 (4.9–32.1)	14.7 (11.4–18.8)	21.3 (12.7–33.6)	29.3 (17.2–45.3)	17.0 (14.9–19.5)	28.7 (23.4–34.5)*	17.6 (8.9–31.9)	19.5 (17.0–22.4)	27.2 (22.4–32.6)
CKD, %	17.0 (5.7–40.9)	12.9 (10.8–15.4)	24.2 (17.6–32.3)*	28.3 (19.6–38.9)§	12.4 (9.9–15.5)	29.9 (25.0–35.2)†	11.0 (7.4–16.0)	12.0 (9.8–14.6)	28.4 (22.8–34.7)*
10-y FCR >20%, %	32.9 (20.2–48.6)	40.1 (35.4–44.9)	50.6 (41.0–60.1)	42.7 (26.7–60.4)	35.6 (32.8–38.5)	52.0 (45.4–58.4)*	29.8 (19.5–42.5)	34.0 (30.8–37.4)	52.7 (46.6–58.7)*
10-y FCR <10%, %	53.9 (38.4–68.7)	39.7 (34.3–45.3)	28.1 (19.1–39.1)	35.8 (23.9–49.9)	41.9 (38.5–45.4)	26.8 (21.6–32.8)	41.1 (27.8–55.8)	47.0 (43.8–50.3)	27.0 (20.9–34.0)

CI indicates confidence interval; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; CKD, chronic kidney disease; and FCR, Framingham 10-year coronary heart disease risk.

*<0.01, †<0.001 between groups within NHANES time period. ‡<0.01, §<0.001 across National Health and Nutrition Examination Survey time periods within the uncontrolled hypertensive groups on 1, 2, and ≥3 medications. To designate differences between time periods, symbols within 1988 to 1994 denote differences with 1999 to 2004, symbols within 1999 to 2004 denote differences with 2005 to 2008, and symbols within 2005 to 2008 indicate differences with 1988 to 1994.

Table 4. Therapeutic Inertia Among Uncontrolled Hypertensive Patients in 3 National Health and Nutrition Examination Survey Periods

Therapeutic Inertia	1988–1994	1999–2004	2005–2008
None	11.3 (9.2–13.5)*	14.6 (12.9–16.4)†	19.8 (17.1–22.4)†
Low	21.3 (18.8–23.8)	24.7 (22.1–27.2)	22.9 (19.5–26.2)
Moderate	29.6 (26.6–32.6)	29.2 (26.3–32.1)	29.0 (26.7–31.3)
High	37.8 (34.8–40.8)*	31.5 (28.4–34.5)	28.4 (25.9–30.8)†

For therapeutic inertia, ≥2 visits per year.

*<0.01, †<0.001 between National Health and Nutrition Examination Survey time periods. Symbols within 1988 to 1994 denote differences with 1999 to 2004; symbols within 1999 to 2004 denote differences with 2005 to 2008; and symbols within 2005 to 2008 indicate differences with 1988 to 1994.

Framingham 10-year CHD risk generally increased with the number of medications, with significant differences in 1999 to 2004 and 2005 to 2008. The percentage of controlled hypertensive patients on ≥4 medications was 2.3% (95% confidence interval, 1.3 to 3.3) in 1988 to 1994, 5.2% (95% confidence interval, 3.6 to 6.8) in 1999 to 2004, and 7.3% (95% confidence interval, 5.1 to 9.4) in 2005 to 2008.

Therapeutic Inertia in Uncontrolled Hypertensive Patients With ≥2 Healthcare Visits Annually

Using the definition provided in Methods, we find that the percentage of patients with no therapeutic inertia rose with time over the 3 NHANES periods, whereas the percentage of patients with high-level therapeutic inertia declined (Table 4). Nevertheless, more than half of uncontrolled hypertensive patients in all time periods had a moderate or high level of therapeutic inertia.

Classes of Antihypertensive Medications

The class of antihypertensive medications reported by controlled and uncontrolled hypertensive patients taking 1, 2, and ≥3 such medications is provided for each of the 3 NHANES periods in Table 5. The NHANES databases do not indicate the order that the antihypertensive agents were added for patients who reported taking 2 and ≥3 BP medications. In all time periods, angiotensin-converting enzyme inhibitors, β-blockers, and calcium channel blockers were the agents most often reported by controlled and uncontrolled hypertensive patients reportedly taking a single antihypertensive medication. Diuretics, especially thiazide-type diuretics, showed the largest increase in percentage use as BP medication number rose from 1 to ≥3. There was a limited number of differences significant at $P<0.01$ between uncontrolled and controlled hypertensive patients who reported taking each class of medication in the 3 NHANES time periods. Nondihydropyridine calcium antagonists were the class of antihypertensive medication with the largest number of significant differences between controlled and uncontrolled patients and were taken more often by those who were uncontrolled.

Untreated Hypertension

In multivariable logistic regression, the clinical variables consistently and independently associated with untreated hypertension across the 3 NHANES periods included male sex, patients with 0 to 1 healthcare visits a year, body mass index <25 kg/m^2, less than stage 3 CKD, and 10-year Framingham 10-year coronary risk 10% to 19% and <10% compared with the reference groups (Figure 2).

Uncontrolled Hypertension on 1 to 2 Blood Pressure Medications

All of the independent variables shown in Figures 3 and 4 were examined simultaneously in multivariable logistic regression analysis. The clinical variables independently associated with uncontrolled hypertension on 1 to 2 BP medications included male sex (1999 to 2004, 2005 to 2008), black race (1988 to 1994, 1999 to 2004), age, and 10-year CHD risk >20% (all time periods for both). Patients on thiazide-type diuretics (1988 to 1994, 1999 to 2004) and angiotensin-converting enzyme inhibitors and/or angiotensin receptor blockers (1999 to 2004, 2005 to 2008) were less likely to have hypertension uncontrolled on 1 to 2 BP medications. In contrast, patients reportedly taking nondihydropyridine calcium channel blockers were more likely to have treated uncontrolled hypertension (1988 to 1994, 2005 to 2008).

Clinical Factors Independently Associated With Apparent Treatment-Resistant Hypertension Among All Uncontrolled Patients

In all time periods, patients reporting ≥4 healthcare visits annually were more likely to have aTRH, ie, uncontrolled on ≥3 BP medications (Figure 4). Other clinical factors consistently and independently associated with aTRH in multivariable logistic regression included obesity, CKD, and 10-year CHD risk >20%. Increasing age and black race were independently linked with aTRH in 2005 to 2008, and patients with 10-year CHD risk 10% to 20% were more likely to have treatment-resistant hypertension in 1988 to 1994 and 1999 to 2004.

No significant differences were seen in the percentages of controlled and uncontrolled hypertensive patients taking various classes of antihypertensive medications in 2005 to 2008, with 1 exception (Figure 5). Nondihyrdropyridine calcium channel blockers were taken more often by uncontrolled than controlled hypertensive patients.

Discussion

The proportion of hypertensive patients with BP ≥140 mm Hg systolic and/or ≥90 mm Hg diastolic declined from 73.2% in 1988 to 1994 to 52.5% in 2005 to 2008 ($P<0.001$; Table 1 and Figure 1).[1,2] Despite progress, >30 million hypertensive patients remain uncontrolled in the United States. The primary objective of this study was to identify consistent characteristics and trends that distin-

Table 5. Antihypertensive Medication Classes Prescribed to Controlled and Uncontrolled Hypertensive Patients by Medication Number

	1988–1994			1999–2004			2005–2008		
	1 Medication	2 Medications	≥3 Medications	1 Medication	2 Medications	≥3 Medications	1 Medication	2 Medications	≥3 Medications
n (%)									
Uncontrolled	846 (51.7)	507 (32.4)	252 (15.9)	684 (43.7)	516 (35.1)	322 (21.2)	379 (40.9)	309 (31.1)	298 (28.0)
Controlled	540 (48.5)	415 (35.0)	195 (16.5)	576 (40.0)	550 (37.2)	383 (22.7)	542 (37.7)	573 (37.0)	454 (25.3)
ACEI									
Uncontrolled	21.9 (17.7–26.7)	30.1 (24.1–36.8)	37.1 (28.1–47.0)	29.3 (24.5–34.5)	38.6 (33.8–43.7)*	50.4 (43.8–56.9)	24.7 (18.8–31.7)*	44.3 (36.2–52.8)	50.8 (42.3–59.2)
Controlled	22.7 (18.3–27.9)	27.9 (22.2–34.4)	36.2 (28.3–45.0)	35.8 (29.6–42.6)	45.5 (41.0–50.1)*	52.6 (45.5–59.5)	33.6 (28.7–38.9)*	44.1 (38.3–50.2)	54.1 (47.5–60.5)
ARB									
Uncontrolled	0 0.0	1.5 (0.8–2.9)	5.7 (3.1–10.3)	7.0 (4.9–9.9)*	17.0 (13.8–20.8)	31.0 (26.1–36.4)	14.6 (10.6–19.7)	21.8 (17.0–27.5)	39.1 (31.4–47.3)
Controlled	0 0.0	0.5 (0.1–1.6)	2.2 (0.9–5.6)	11.0 (8.4–14.3)*	19.9 (16.1–24.3)	27.9 (22.6–33.9)	18.0 (13.5–23.7)	26.9 (22.1–32.2)	34.1 (27.8–41.1)
α-Blocker									
Uncontrolled	3.1 (1.7–5.6)	2.1 (1.0–4.1)	10.9 (6.4–18)	5.7 (3.8–8.5)*	2.5 (1.6–4.0)	10.6 (7.3–15.2)	1.5 (0.7–3.2)	3.0 (1.4–6.7)	7.9 (5.2–11.7)
Controlled	3.7 (2–6.8)	2.5 (1.2–5.0)	4.2 (1.6–10.8)	1.6 (0.8–3.4)*	3.7 (2.5–5.4)	10.7 (8.1–14.0)	0.6 (0.1–2.2)	4.9 (2.7–8.6)	7 (4.7–10.4)
α,β-Blocker									
Uncontrolled	1.0 (0.3–2.9)	2.1 (1.1, 4.2)	3.3 (1.5–7.2)	0.5 (0.2–1.3)	1.0 (0.4–2.6)	5.5 (2.7–11.0)	0.9 (0.2–3.7)	2.2 (1.1–4.5)	7.4 (4.5–11.9)
Controlled	0.8 (0.1–4.5)	2.3 (0.9–5.6)	4.2 (1.5–10.9)	0.8 (0.2–2.8)	1.0 (0.3–2.8)	6.9 (5.1–9.4)	0.9 (0.3–2.8)	1.2 (0.6–2.6)	7 (4.3–11.4)
β-Blocker									
Uncontrolled	21.5 (17.3–26.4)*	27.5 (21.4–34.6)	37.5 (29.1–46.8)	20.7 (16.4–25.7)	34.3 (29.6–39.3)	54.6 (46.9–62.1)	26.4 (20.5–33.4)	36.4 (29.5–44)	62.1 (57.2–66.8)
Controlled	29.5 (23.8–35.9)*	31.4 (26–37.5)	43.9 (33.6–54.8)	20.8 (16.5–25.9)	31.3 (26.8–36.2)	47.4 (42.3–52.6)	24.2 (18.8–30.6)	30.0 (24.6–36)	62.4 (57.3–67.3)
dCCB									
Uncontrolled	9.3 (7.1–12.2)	14.4 (10.4–19.6)	19.3 (12.2–29.3)	12.6 (9.3–16.9)	18.9 (14.8–23.8)	33.3 (26.5–41.0)	7.7 (4.3–13.2)	20.0 (14.5–27)	40.0 (33.6–46.7)
Controlled	7.9 (5.2–11.9)	14.7 (10–21.1)	17.2 (11.3–25.3)	12.8 (9.9–16.4)	15.9 (13.3–19.0)	39 (33.8–44.6)	8.2 (5.6–11.8)	23.9 (19.6–28.9)	38.6 (32.5–45.2)
ndCCB									
Uncontrolled	24.2 (19.8–29.3)*	21.6 (16.6–27.6)*	32.2 (25.1–40.2)	12.2 (9.1–16)*	12.9 (9.9–16.7)	20.5 (15.3–27.0)	6.4 (4.0–10.1)*	7.9 (5.4–11.4)*	18.9 (13.8–25.5)
Controlled	11.2 (8.0–15.4)*	13.1 (8.6–19.6)*	25.0 (18.6–32.8)	5.4 (3.6–8.2)*	11.3 (8.6–14.7)	14.5 (10.8–19.2)	1.8 (1.0–3.3)*	2.9 (1.7–4.8)*	14.8 (10.5–20.4)
Diuretic									
Uncontrolled	13.9 (11.5–16.6)	67.5 (60.9–73.5)*	93.4 (86.0–97.0)	9.8 (7.1–13.4)	63.0 (57.8–67.9)	84.3 (77.9–89.1)	15.4 (10.8–21.5)	52.4 (42.9–61.8)	83.9 (76.0–89.5)
Controlled	18.6 (14.7–23.2)	76.3 (69.4–82.1)*	93.5 (87.1–96.9)	10.7 (7.8–14.5)	61.6 (56.3–66.6)	90.1 (85.5–93.4)	12.5 (9.2–16.6)	60.8 (55.2–66.1)	87.4 (83–90.7)
Aldosterone antagonist									
Uncontrolled	0.7 (0.2–2.6)	3.5 (2.1–5.6)	3.1 (1.4–6.8)	0.3 (0.0–2.0)	0.6 (0.2–1.8)	5.1 (2.8–9.2)	0.0	0.9 (0.2–3.7)	4.4 (1.8–10.4)
Controlled	0.1 (0–0.4)	3.6 (1.8–7.3)	1.7 (0.6–4.7)	0.4 (0.1–1.9)	1.5 (0.6–3.6)	4.6 (2.7–7.8)	0.3 (0.1–1.4)	0.7 (0.3–1.7)	6.9 (4.5–10.4)
K^+ sparing									
Uncontrolled	1.9 (1.0–3.5)	22.8 (17.6–29.1)	45.2 (35.2–55.5)	1.2 (0.5–2.8)	10.2 (7.1–14.6)	19.2 (14.3–25.2)	1.6 (0.6–4.4)	7.5 (4.3–12.7)	16.1 (11.2–22.6)
Controlled	3.0 (2.0–4.4)	22.6 (17.2–29.0)	55.4 (45.9–64.5)	1.3 (0.7–2.4)	9.7 (6.6–14)	26.1 (21.4–31.4)	0.4 (0.1–1.3)	6.1 (4.1–8.9)	18.4 (14.7–22.8)
Loop diuretic									
Uncontrolled	3.9 (2.8–5.5)	15 (11.1–19.9)	26.4 (19.7–34.4)*	2.8 (1.5–5.3)	12.6 (9–17.3)	24.2 (18.6–30.8)	1.1 (0.4–2.6)	10.2 (6.4–15.7)	27.1 (19.2–36.8)
Controlled	2.9 (1.5–5.4)	12.3 (8.7–17)	15.4 (11.2–20.9)*	1.8 (0.9–3.5)	7.9 (5.6–11.1)	26.9 (20.9–33.8)	0.9 (0.4–2.3)	6.7 (4.3–10.2)	26.8 (22.9–31.1)
Thiazide diuretic									
Uncontrolled	7.4 (5.6–9.6)*	48.5 (41.6–55.4)*	73.1 (62.2–81.8)	5.5 (3.6–8.3)	47.7 (41.8–53.6)	59.1 (53.0–65.0)	12.7 (8.6–18.4)	41.5 (32.6–51)	61.3 (53.3–68.7)
Controlled	12.6 (8.9–17.7)*	59.7 (52.7–66.4)*	79.6 (72.4–85.4)	7.2 (5–10.4)	50.3 (44.3–56.2)	64.7 (58.2–70.7)	10.8 (7.9–14.6)	51.5 (46.1–56.9)	61.3 (55.6–66.6)
Sympatholytic									
Uncontrolled	4.5 (3.3–6.2)	9.1 (6.7–12.4)	21.2 (15.0–9.2)	2.3 (1.3–3.9)	2.8 (1.7–4.7)	13.9 (9.5–19.8)*	2.2 (0.7–6.6)	3.5 (1.4–8.8)	8.6 (5.2–13.9)*
Controlled	5.6 (3.3–9.4)	8.9 (5.7–13.7)	21.7 (15.9–29.0)	1.0 (0.4–2.8)	2.1 (1.0–4.6)	6.1 (3.9–9.4)	0.2 (0.1–0.4)	0.7 (0.2–1.9)	2.5 (1.3–4.7)*
Vasodilator									
Uncontrolled	0.6 (0.2–1.7)	1.9 (0.6–5.4)	11.1 (6.6–18.0)	0.0	0.9 (0.3–3.0)	4.9 (2.9–8.2)	0.3 (0.1–1.3)	0.7 (0.2–2.2)	5.2 (3.1–8.6)*
Controlled	0.0	0.6 (0.1–2.4)	9.7 (5.9–15.5)	0.0	0.0	1.3 (0.6–2.8)	0.0	0.4 (0.1–2.2)	1.2 (0.5–2.8)*

ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CCB, calcium channel blocker; d, dihydropyridine; and nd, nondihydropyridine.

*$P<0.01$, uncontrolled versus controlled for medication and time period.

guished uncontrolled from controlled hypertensive patients. The study focused on pursuing this objective in 3 groups of uncontrolled patients: those who are untreated and those reportedly taking 1 to 2 and ≥3 BP medications.

Untreated Hypertension

Hypertension treatment increased steadily from 1988 to 2008,[1,2,10] yet more than half of uncontrolled patients were untreated in the 3 NHANES periods. Although hypertension

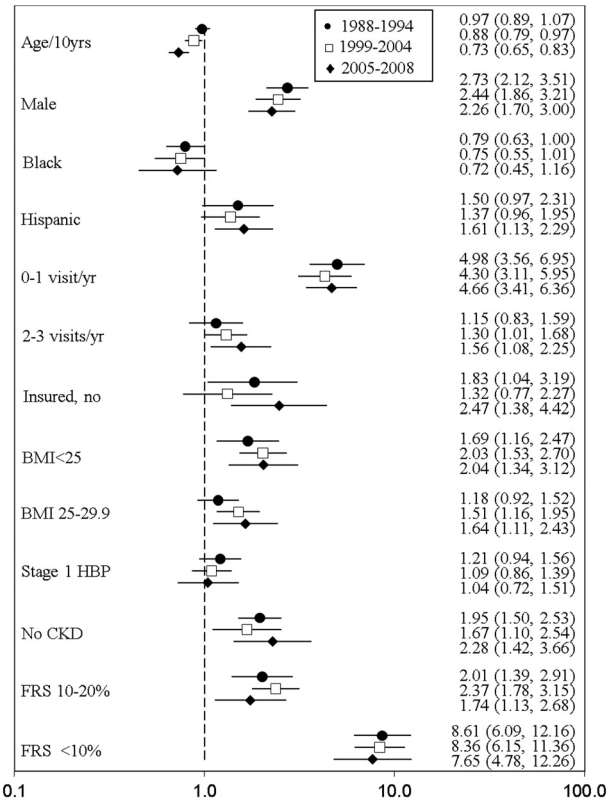

Figure 2. The independent relationships between selected clinical variables and the dependent variable, untreated hypertension, as multivariable odds ratios and 95% confidence intervals for each of the 3 National Health and Nutrition Examination Survey periods. The reference group for comparison is all uncontrolled hypertensive patients. Confidence intervals that do not cross the line of identity (1.0) are considered statistically significant. BMI indicates body mass index; CKD, chronic kidney disease; and FRS, Framingham risk score.

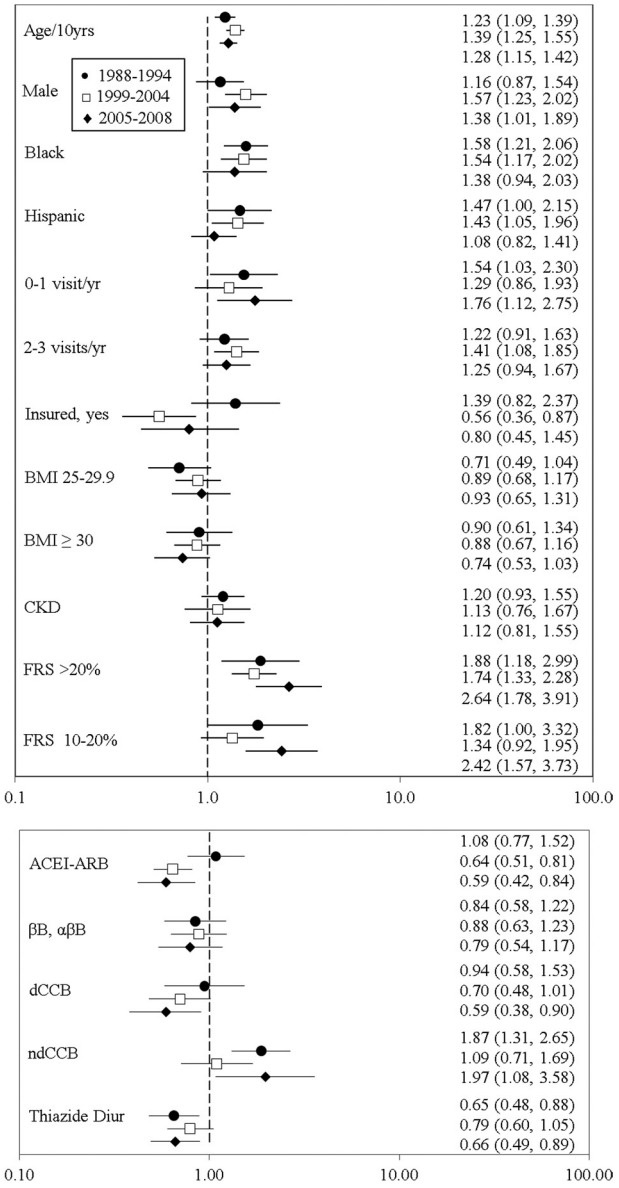

Figure 3. The independent relationship between selected clinical variables, including class of antihypertensive medications, and the dependent variable, uncontrolled hypertension, on 1 to 2 antihypertensive medications as multivariable odds ratios and 95% confidence intervals for each of the 3 National Health and Nutrition Examination Survey periods. The reference group is all hypertensive patients who reported taking 1 to 2 blood pressure medications. Confidence intervals that do not cross the line of identity (1.0) are considered statistically significant. ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; βB, β-blocker; d, dihydropyridine; nd, nondihydropyridine; CCB, calcium channel blocker; and Diur, diuretic.

awareness improved over the same time period, roughly two thirds of untreated patients in all surveys were unaware (Table 2). Patient characteristics independently associated with untreated hypertension, including both unaware and aware patients, across the 3 NHANES periods included male sex, infrequent health care, lean body mass index, absence of CKD, and 10-year Framingham CHD risk <10% and 10% to 20% (Figure 2), ie, better cardiovascular and renal health. Infrequent health care emerged as a major issue; a mean of ≥40% of untreated hypertensive patients in all survey periods had 0 to 1 healthcare visits annually. Lack of insurance is a factor limiting healthcare use, regardless of income.[24] Uninsured status rose with time among uncontrolled patients (Table 1) and was independently linked with untreated hypertension in 2 of 3 NHANES periods (Figure 2), an association noted previously.[25]

The findings among untreated hypertensive patients suggest that increasing healthcare use in traditional or nontraditional settings, eg, worksites,[26] is critical in reducing the burden of untreated hypertension. Raising the perceived value of regular preventive healthcare services among those without clinically overt disease emerges as an important complementary educational strategy. Screening efforts to raise hypertension awareness, especially among medically underserved groups and individuals at lower risk, should include inquiries on regular use of primary care and plans to engage infrequent users and nonusers in ongoing primary care. Initiatives to reduce the growing number of uninsured adults also emerge as important in addressing the substantial burden of untreated uncontrolled hypertension.

Focus on Uncontrolled Hypertension Treated With 1 to 2 Blood Pressure Medications

Approximately one third of all uncontrolled patients reported taking 1 to 2 antihypertensive medications in all 3 NHANES

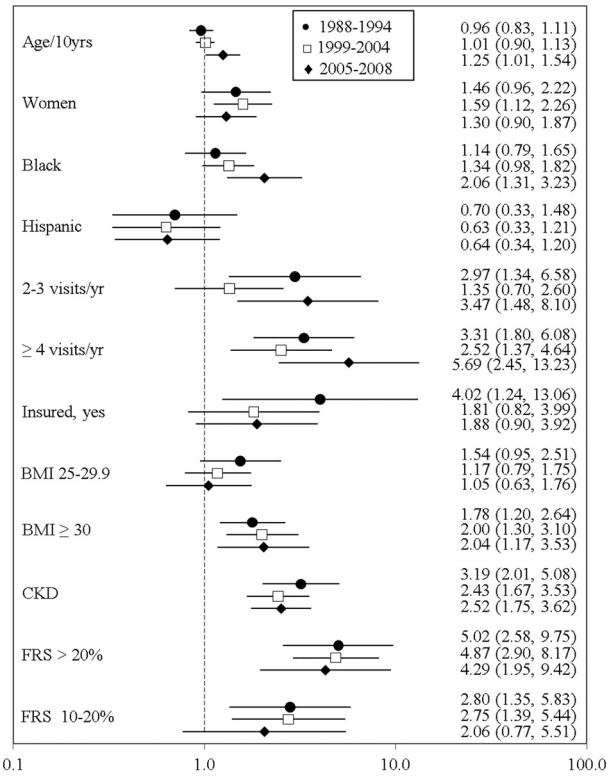

Figure 4. The independent relationships between selected clinical variables and the dependent variable, apparent treatment-resistant hypertension (uncontrolled on ≥3 blood pressure medications), as multivariable odds ratios and 95% confidence intervals for the 3 National Health and Nutrition Examination Survey periods. The reference group is all uncontrolled hypertensive patients. Confidence intervals that do not cross the line of identity (1.0) are considered statistically significant. BMI indicates body mass index; CKD, chronic kidney disease; and FRS, Framingham risk score.

periods. However, among treated uncontrolled patients, the proportion on 1 to 2 medications fell (Table 3). One logical option for improving BP control in this comparatively large group of uncontrolled patients is an additional antihypertensive medication. Clinical variables independently linked to uncontrolled hypertension on 1 to 2 BP medications included increasing (older) age and 10-year Framingham coronary risk >20% in all 3 time periods and male sex, Hispanic ethnicity, and infrequent healthcare in 2 NHANES periods (Figure 3).

The comparatively higher risk among uncontrolled than controlled hypertensive patients on 1 to 2 medications provides further justification for adding a second or third antihypertensive medication to improve BP control. Their mean systolic BP was >150 mm Hg across surveys, with many having stage 2 hypertension, which should also prompt treatment intensification. Whereas infrequent health care was a distinguishing characteristic of treated uncontrolled hypertension on 1 to 2 BP medications, roughly 85% to 90% of this group had ≥2 healthcare visits annually. Thus, the majority appear to be seen sufficiently frequently to allow treatment intensification.

Our previous work identified therapeutic inertia as a significant contributor to uncontrolled hypertension, accounting for ≈19% of the total variance in BP control.[5] Although the NHANES database does not include information required to calculate therapeutic inertia,[4,5] it was arbitrarily defined on the basis of BP, number of antihypertensive medications, and 10-year CHD risk. Whereas high-level therapeutic inertia declined with time (Table 1), therapeutic inertia was high or moderate in more than half of uncontrolled hypertensives who reported ≥2 healthcare visits annually in all 3 NHANES periods (Table 4). Therapeutic inertia is not a provider-only trait but appears to reflect a patient-provider interaction.[5] In addition to provider interventions to reduce therapeutic inertia, educating patients, especially those at higher risk, on the importance of BP control may facilitate efforts to overcome therapeutic inertia.

The data also suggest that medication selection affects control. Patients uncontrolled compared with controlled on 1 to 2 BP medications were less likely to report taking a diuretic (1988 to 1994, 2005 to 2008) and less likely to report taking an angiotensin-converting enzyme inhibitor or angiotensin

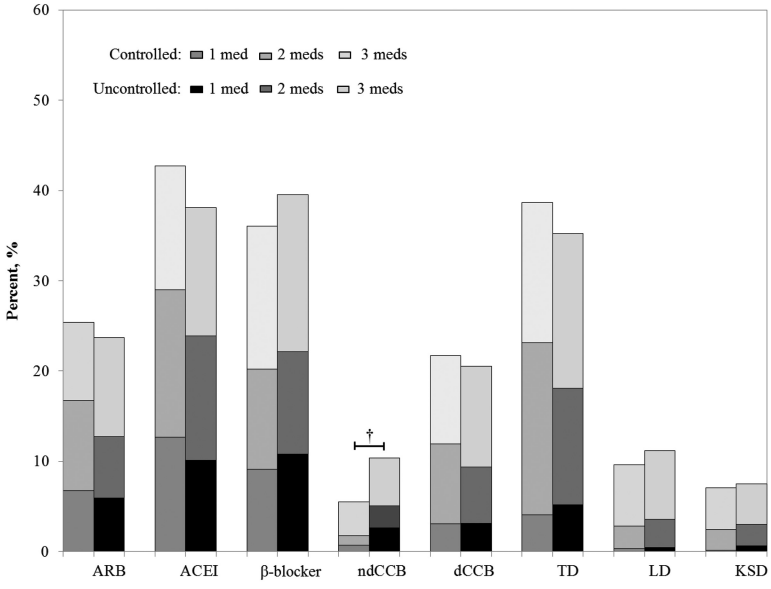

Figure 5. The percentage of controlled and uncontrolled hypertensive patients taking various classes of antihypertensive medications for National Health and Nutrition Examination Survey 2005 to 2008 only. The percentages of patients within each bar are further subdivided by those who are taking the medication class indicated as monotherapy or as part of a 2 or ≥3 antihypertensive medication regimen. The denominator is all controlled or uncontrolled patients within each NHANES period. ARB indicates angiotensin receptor blocker; ACEI, angiotensin-converting enzyme inhibitor; nd, nondihydropyridine; d, dihydropyridine; CCB, calcium channel blocker; TD, thiazide diuretic; LD, loop diuretic; and KSD, K^+-sparing diuretic. †$P<0.01$ between controlled and uncontrolled patients for the medication class indicated.

receptor blocker (1999 to 2004, 2005 to 2008). The findings align with the efficacy of diuretics and renin-angiotensin system blockers, especially in combination, for BP control.[27] Although significant only in 2005 to 2008, nondihydropyridine calcium channel blockers may also improve BP control, consistent with the antihypertensive efficacy of nondihydropyridine calcium channel blocker as monotherapy and in combination with angiotensin-converting enzyme inhibitor combinations.[14,28]

Focus on Apparent Treatment-Resistant Hypertension

The proportion of treated uncontrolled hypertensive patients reportedly taking ≥3 BP medications increased from 15.9% in 1988 to 1994 to 28.0% in 2005 to 2008 (Table 3 and Figure 1C). These patients appear to have treatment-resistant hypertension, although 30% to 50% may have pseudohypertension, which includes nonadherence, inaccurate measurements, and artifacts, eg, office or white-coat effect.[7,29] Although our report focuses on uncontrolled aTRH, the American Heart Association position statement also identified patients with controlled hypertension taking ≥4 medications as treatment resistant.[7] With this definition and data presented in the tables and the Results section, 11.8% of all hypertensive patients in 2005 to 2008 have aTRH, an increase from 5.5% in 1988 to 1994 and 8.5% in 1999 to 2004.

In multivariable analysis, clinical factors independently linked with uncontrolled aTRH across surveys included frequent healthcare use (≥4 healthcare visits annually), which indicates that the medical community has numerous opportunities to improve BP control. The patients with aTRH are further characterized by obesity, CKD, and 10-year Framingham coronary risk >20% (Figure 4). In 2005 to 2008, older age and black race and in 1999 to 2004 female sex emerged as independent clinical correlates of aTRH. The clinical factors independently associated with aTRH identified are consistent with characteristics previously cited.[7] Patients with aTRH are generally at significant risk for cardiovascular disease and likely to benefit from better BP control.

Limited effectiveness of current antihypertensive medications and strategies for combining them constitute a barrier to better hypertension control. Of particular note was the infrequent use of aldosterone antagonists among patients with aTRH (Table 5 and Figure 5). Several trials indicate that the addition of an aldosterone antagonist lowers BP 20 to 25/10 to 15 mm Hg in patients with treatment-refractory and -resistant hypertension.[30,31] More effective antihypertensive medications or strategies for combining them are urgently needed because the burden of treatment resistant hypertension is likely to grow given an aging population with more obesity and related complications, including diabetes mellitus and CKD. Personalized medicine, including hemodynamic and renin-guided therapeutics,[32,33] and genetic testing[34] offer alternative or complementary approaches to constructing more effective medication regimens for treatment-resistant patients.

Study Limitations

This study has limitations. Although NHANES represents the noninstitutionalized civilian US population, the sample size is relatively small. Thus, not all clinically and epidemiologically important differences may be detected. Second, medications were determined by self-report, which may be inaccurate, although >85% of hypertensive patients brought their medications to the 1999 to 2004 and 2005 to 2008 examinations. Adherence was not assessed and medication dose and frequency were not recorded. Third, hypertension was defined by BP on a single visit. Thus, hypertension status may have been incorrectly assigned to some patients, especially the unaware, untreated subset, which had lower BPs than uncontrolled treated patients. Fourth, although lifestyle change is also important to BP control, our analysis focused on treatment. Fifth, sample size, although substantial, is comparatively small for subgroup analyses, which increases the potential for falsely accepting the null hypothesis, ie, no differences between groups. Although appropriate for the large number of statistical comparisons performed in the analysis, the concern of limited power is exacerbated by recognizing statistical significance only at $P<0.01$.

Despite the limitations, our analyses of a nationally representative hypertensive patient sample from 3 NHANES periods suggest that national efforts to increase healthcare insurance and use of primary care could further improve hypertension awareness and treatment, leading to higher control rates. These efforts are important for untreated uncontrolled hypertensive patients who are more often men, nonobese, and without overt cardiovascular and renal diseases. Uncontrolled hypertensive patients on 1 to 2 BP medications could benefit from an additional antihypertensive medication. These patients are generally seen frequently enough to have therapy intensified. They are older and have greater risk for CHD than their controlled counterparts taking 1 to 2 BP medications; ie, there appear to be compelling reasons to intensify therapy. This group is also more likely to include men, blacks, and Hispanics and to have stage 2 hypertension, although these characteristics were not significant in all time periods. Interventions to reduce therapeutic inertia, which should include efforts directed at both providers and patients, could be useful for improving their BP control and reducing risk.

Conclusions

A growing proportion of hypertensive patients appear to be resistant to treatment. Strategies to enhance therapeutic efficacy and to promote therapeutic adherence and lifestyle change are especially important for this group. Trends toward an older and more obese population with a higher prevalence of diabetes mellitus and CKD could lead to a growing burden of treatment-resistant hypertension.[7] To counter these potentially adverse trends and to improve overall hypertension control, integrated healthcare research, policy, and delivery initiatives are needed to reverse growth in unhealthy lifestyles and obesity,[35,36] to enhance regular use of a medical home, to reduce therapeutic inertia, to develop more efficacious antihypertensive agents, and to improve methods for selecting

effective antihypertensive combinations for individual patients.

Sources of Funding

This work was supported in part by the state of South Carolina (Hypertension Initiative), National Institutes of Health (NIH) R01 National Heart, Lung and Blood Institute HL07080684, NIH R01 National Institute of Diabetes and Digestive and Kidney Diseases DK067615, NIH R01 National Institute of Neurological Disorders and Stroke NS058728, and US Army W81XWH-10–2-0057. The funding agencies were not involved in the design or conduct of the study; collection, management, analysis, and interpretation of the data; or the preparation, review, or approval of the manuscript.

Disclosures

Dr Egan has received grant support from Daiichi-Sankyo, Novartis, and Takeda; has served as a lecturer with honoraria on CME-accredited programs for the American Society of Hypertension Carolinas-Georgia-Florida Chapter and International Society of Hypertension in Blacks; and has been a consultant to NicOx. Dr Ferdinand has served on the speakers' bureau at AstraZeneca, Novartis, Forest, and Daiichi-Sankyo; has received honoraria from AstraZeneca, Novartis, and Forest; and has served as a consultant/advisory board member for AstraZeneca, Novartis, and Forest. The other authors report no conflicts.

References

1. Hajjar I, Kotchen TA. Trends in prevalence, awareness, treatment and control of hypertension in the United States, 1988–2000. *JAMA*. 2003; 290:199–206.
2. Egan BM, Zhao Y, Axon RN. US trends in prevalence, awareness, treatment, and control of hypertension, 1988–2008. *JAMA*. 2010;303: 2043–2050.
3. US Census Bureau. Statistical abstract of the United States: 2011. http://www.census.gov/compendia/statab/2011/tables/11s0007.pdf. Accessed February 17, 2011.
4. Rose AJ, Berlowitz DR, Manze M, Orner MB, Kressin NR. Intensifying therapy for hypertension despite suboptimal adherence. *Hypertension*. 2009;54:524–529.
5. Okonofua EC, Simpson K, Jesri A, Rehman S, Durkalski V, Egan BM. Therapeutic inertia is an impediment to achieving the Healthy People 2010 blood pressure control goals. *Hypertension*. 2006;47:1–7.
6. Wang JT, Vasan RS. Epidemiology of uncontrolled hypertension in the United States. *Circulation*. 2005;112:1651–1662.
7. Calhoun DA, Jones D, Textor S, Goff DC, Murphy TP, Toto RD, White A, Cushman WC, White W, Sica D, Ferdinand K, Giles TD, Falkner B, Carey RM; American Heart Association Professional Education Committee. Resistant hypertension: diagnosis, evaluation, and treatment: a Scientific Statement from the American Heart Association Professional Education Committee of the Council for High Blood Pressure Research. *Hypertension*. 2008;51:1403–1419.
8. Cutler JA, Sorlie PD, Wolz M, Thom T, Fields LE, Roccella EJ. Trends in the hypertension prevalence, awareness, treatment, and control rates in United States adults between 1988–1994 and 1999–2004. *Hypertension*. 2008;52:818–827.
9. Centers for Disease Control. National Center for Health Statistics Research Ethics Review Board. http://www.cdc.gov/nchs/nhanes/irba98.htm. Accessed February 17, 2011.
10. Burt VL, Cutler JA, Higgins M, Horan MJ, Labarthe D, Whelton P, Brown C, Roccella EJ. Trends in the prevalence, awareness, treatment, and control of hypertension in the US adult population: data from the Health Examination Surveys, 1960–1991. *Hypertension*. 1995;26:60–69.
11. The 1988 Report of the Joint National Committee on Detection, Evaluation and Treatment of High Blood Pressure. *Arch Intern Med*. 1988; 148:1023–1038.
12. The fifth report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (JNC V). *Arch Intern Med*. 1993;153:154–183.
13. The sixth report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Arch Intern Med*. 1997;157:2413–2446.
14. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jones DW, Materson BJ, Oparil S, Wright JT Jr, Roccella EJ. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension*. 2003;42: 1206–1252.
15. Accord Study Group. Effects of intensive blood-pressure control in type 2 diabetes mellitus. *N Engl J Med*. 2010;362:1575–1585.
16. Appel LJ, Wright JT Jr, Greene T, Agodoa LY, Astor BC, Bakris G, Cleveland WH, Charleston J, Contreras G, Faulkner ML, Gabbai FB, Gassman JJ, Hebert LA, Jamerson KA, Kopple JD, Kusek JW, Lash JP, Lea JP, Lewis JB, Lipkowitz MS, Massry SG, Miller ER, Norris K, Phillips RA, Pogue VA, Ranall OS, Rostand SG, Smorgorzewski MJ, Toto RD, Wang X; AASK Collaborative Research Group. Intensive blood pressure control in hypertensive chronic kidney disease. *N Engl J Med*. 2010;363:974–976.
17. Stevens LA, Coresh J, Feldman HI, Greene T, Lash JP, Nelson RG, Rahman M, Deysher AE, Zhang Y, Schmid CH, Levey AS. Evaluation of the Modification of Diet in Renal Disease equation in a large diverse population. *J Am Soc Nephrol*. 2007;18:2749–2757.
18. Jones CA, Francis ME, Eberhardt MS, Chavers B, Engelgau M, Kusek JW, Byrd-Holt D, Narayan KMV, Herman WH, Jones CP, Salive M, Agaodoa LY. Microalbuminura in the US population: Third National Health and Nutrition Examination Survey. *Am J Kid Dis*. 2002;39: 445–459.
19. Selvin E, Manzi J, Stevens LA, Van Lente F, Lacher DA, Levey AS, Coresh J. Calibration of serum creatinine in the National Health and Nutrition Examination Surveys (NHANES) 1988–1994, 1999–2004. *Am J Kidney Dis*. 2007;59:918–926.
20. Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diabetes Care*. 1997;20:1183–1197.
21. Harris MI, Goldstein DE, Flegal KM, Little RR, Cowie CC, Widemeyer H-M, Eberhardt MS, Byrd-Holt DD. Prevalence of diabetes, impaired fasting glucose, and impaired glucose tolerance in U.S. adults; the Third National Health and Nutrition Examination Survey, 1988–1994. *Diabetes Care*. 1998;21:518–524.
22. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on the Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA*. 2001;285:2486–2497.
23. National Center for Health Statistics; Centers for Disease Control and Prevention. The National Health and Nutrition Examination Surveys: analytic and reporting guidelines. Last update: December 2005. Last correction, September 2006. http://www.cdc.gov/NCHS/data/nhanes/nhanes_03_04/nhanes_analytic_guidelines_dec_2005.pdf. Accessed February 17, 2010.
24. Ross JS, Bradley EH, Busch SH. Use of health care services by lower-income and higher-income uninsured adults. *JAMA*. 2006;295: 2027–2036.
25. Ostchega Y, Hughes JP, Wright JD, McDowell MA, Louis T. Are demographic characteristics, health care access and utilization, and comorbid conditions associated with hypertension among U.S. adults? *Am J Hypertens*. 2008;21:159–165.
26. Erfurt JC, Foote A, Heirich MA. The cost-effectiveness of work-site wellness programs for hypertension control, weight loss, and smoking cessation. *J Occup Med*. 1991;33:962–970.
27. Sica DA. Rationale for fixed-dose combinations in the treatment of hypertension: the cycle repeats. *Drugs*. 2002;62:443–462.
28. Jamerson K, Weber MA, Bakris GL, Dahlof B, Pitt B, Shi V, Hester, A, Gupte J, Gatlin M, Velazquez EJ; ACCOMPLISH Trial Investigators. Benazepril plus amlodipine or hydrochlorothiazide for hypertension in high-risk patients. *N Engl J Med*. 2008;359:2417–2428.
29. de la Sierra A, Segura J, Banegas JR, Gorostidi M, de la Cruz JJ, Armario P, Oliveras A, Ruilope LM. Clinical features of 8295 patients with resistant hypertension classified on the basis of ambulatory blood pressure monitoring. *Hypertension*. 2011;57:898–902.
30. Chapman N, Dobson J, Wilson S, Dahlöf B, Sever PS, Wedel H, Poulter NR; Anglo-Scandinavian Cardiac Outcomes Trial Investigators. Effect of spironolactone on blood pressure in subjects with resistant hypertension. *Hypertension*. 2007;49:839–845.
31. Pimenta E, Calhoun DA. Resistant hypertension and aldosteronism. *Curr Hypertens Rep*. 2007;9:353–359.
32. Taler SJ, Textor SC, Augustine JE. Resistant hypertension: comparing hemodynamic management to specialist care. *Hypertension*. 2002;39: 982–988.

33. Egan BM, Basile JN, Rehman SU, Strange P, Grob C, Riehle J, Walters C, Lackland DT, Sealey JE, Laragh JH. Renin-guided algorithm matches clinical hypertension specialist care in uncontrolled hypertension: a randomized-controlled clinical trial. *Am J Hypertens*. 2009;22:792–801.
34. Mellen PB, Herrington DM. Pharmacogenomics of blood pressure response to antihypertensive treatment. *J Hypertens*. 2005;23:1311–1325.
35. Mellen PB, Gao SK, Vitolins MZ, Goff DC. Deteriorating dietary habits among adults with hypertension. *Arch Intern Med*. 2008;168:308–314.
36. Ford ES, Zhao G, Li C, Pearson WS, Mokdad AH. Trends in obesity and abdominal obesity among hypertensive and nonhypertensive adults in the United States. *Am J Hypertens*. 2008;21:1124–1128.

CLINICAL PERSPECTIVE

Defining the characteristics of uncontrolled hypertensive patients may facilitate efforts to improve blood pressure control. Data were analyzed for 13 375 hypertensive adults from the National Health and Nutrition Examination Surveys for 1988 to 1994, 1999 to 2004, and 2005 to 2008. Multivariable logistic regression was used to identify clinical characteristics associated with untreated hypertension, hypertension uncontrolled on 1 to 2 blood pressure medications, and apparent treatment-resistant hypertension on ≥3 blood pressure medications. More than half of uncontrolled hypertensives were untreated, including 52.5% in 2005 to 2008, with about two thirds of them unaware of their hypertension. Untreated hypertensive patients were more often men, infrequent users of primary health care, lean, and without clinical cardiovascular or renal disease. Most treated uncontrolled patients reported taking 1 to 2 blood pressure medications, a proxy for therapeutic inertia. This group, which was older and had higher 10-year coronary heart disease risk than patients controlled on 1 to 2 medications, comprised 34.4% of all uncontrolled and 72.0% of treated uncontrolled patients in 2005 to 2008. Apparent treatment-resistant hypertension increased from 15.9% (1998 to 2004) to 28.0% (2005 to 2008) of treated patients ($P<0.001$). Clinical characteristics associated with apparent treatment-resistant hypertension included ≥4 visits a year, obesity, chronic kidney disease, and 10-year coronary heart disease risk >20%. Adherence to health lifestyles and medications is important for all patients. Raising hypertension awareness among infrequent users of primary health care and linking them to a medical home could reduce untreated hypertension. Uncontrolled patients on 1 to 2 blood pressure medications could benefit from an additional antihypertensive medication. More effective selection of antihypertensive combination therapy is important for the growing proportion of patients with apparent treatment-resistant hypertension.

Go to http://cme.ahajournals.org to take the CME quiz for this article.