Closing the Gap in Hypertension Control Between Younger and Older Adults

National Health and Nutrition Examination Survey (NHANES) 1988 to 2010

Brent M. Egan, MD; Jiexiang Li, PhD; Ibrahim F. Shatat, MD; J. Michael Fuller, MD; Angelo Sinopoli, MD

Background—Joint National Committee goal blood pressure for all adults was <140/<90 mm Hg or lower from 1984 to 2013. Adults aged ≥60 years (older) have mainly isolated systolic hypertension, with major trials attaining systolic blood pressure <150 but not <140 mm Hg. The main objective was to assess changes in hypertension control to <140/<90 mm Hg in younger (aged <60 years) and older adults and <150/<90 mm Hg in the latter.

Methods and Results—National Health and Nutrition Examination Surveys (NHANES) 1988 to 1994, 1999 to 2004, and 2005 to 2010 were analyzed in adults aged ≥18 years. From 1988 to 1994 to 2005 to 2010, hypertension control to <140/<90 mm Hg improved in older (31.6% to 53.1%; P<0.001) and younger (45.7% to 55.9%; P<0.001) patients. The age gap in control declined from 14.1% (P=0.01) in 1988 to 1994 to 2.8% (P=0.13) in 2005 to 2010. Better hypertension control reflected increased percentages of older (55.6% to 77.5%) and younger (34.6% to 54.7%) patients on treatment and treated older (45.7% to 64.9%) and younger (56.8% to 73.4%) patients controlled (all P<0.001). Control to <150/<90 mm Hg rose from 48.8% to 69.9% in older adults. Antihypertensive medication number and percentages on ≥3 medications increased in both age groups but increased more in older patients (P<0.01). Blood pressure control was higher in both age groups with ≥2 healthcare visits per year and on statin therapy.

Conclusions—The age gap in hypertension control to <140/<90 mm Hg was virtually eliminated in 2005 to 2010 as clinicians intensified therapy, especially in older patients in whom isolated systolic hypertension predominates, controlling 70% to <150/<90 mm Hg. More frequent healthcare visits and the use of statin therapy may improve hypertension control in all adults. (Circulation. 2014;129:2052-2061.)

Key Words: aged ■ blood pressure ■ epidemiology ■ hypertension ■ population ■ prevention

Hypertension affects one third of US adults,1 rising from <10% before the fifth decade to ≥60% by the seventh decade.2 The relative risk of cardiovascular events when blood pressures (BPs) are >115/>75 mm Hg at any given age is relatively constant over the adult life span, yet absolute risk rises steeply with increasing age.3 The absolute reduction in cardiovascular events with antihypertensive treatment also increases with age.4

Clinical Perspective on p 2061

On the basis of Joint National Committee reports,5,6 goal BP was <140/<90 mm Hg for all adults from 1984 to 2013. Prior research showed that the largest group of uncontrolled hypertensive patients are older individuals with stage 1 isolated systolic hypertension (ISH), that is, BP of 140 to 159/<90 mm Hg.7 Three major factors may explain lesser success in controlling BP to <140/<90 mm Hg in older than in younger hypertensive patients. First, ISH, which increases with age,8 is more resistant to antihypertensive medications.9 Second, clinicians are more reluctant to initiate and intensify treatment for stage 1 ISH, that is, therapeutic inertia.10,11 Older patients also appear less concerned with elevated systolic than diastolic BP.12 Third, randomized, controlled trials of ISH enrolled adults aged ≥60 years with systolic BP ≥160 mm Hg (stage 2) and achieved on-treatment mean systolic BP values between 143 and 152 mm Hg.13 Although observational studies support goal BP lower than <140/<90 mm Hg, for example, <120/<80 mm Hg,7 randomized, interventional trials support on-treatment goal BP of <150/<90 mm Hg in patients aged ≥60 years with ISH.14

Given this background, the main study objective was to assess time-dependent changes in hypertension control to
<140/<90 mm Hg in adults aged <60 years (younger) and aged ≥60 years (older), as well as an evidence-based goal of <150/<90 mm Hg in older adults. Secondary objectives were to identify clinical factors associated with BP control in younger and older adults and to calculate change in predicted 10-year atherosclerotic cardiovascular disease (ASCVD) risk with an on-treatment 10-mm Hg systolic BP reduction in untreated older adults with BP of 140 to 149/<90 mm Hg.

Methods
The National Health and Nutrition Examination Survey (NHANES) program uses a complex sampling design to select a representative sample of the civilian, noninstitutionalized US population. All adults provided written consent to participate in NHANES, which was approved by the Review Committee of the National Center for Health Statistics.

Participants included adults aged ≥18 years in NHANES III (1988–1994), 1999 to 2004, or 2005 to 2010. Race/ethnicity was determined by self-report and separated into non-Hispanic white (white), non-Hispanic black (black), and Hispanic ethnicity of any race.

Mean systolic and diastolic BPs were determined per NHANES reporting guidelines, excluding the first value in adults with >1 measurement.

Traditional hypertension was defined by systolic BP ≥140 mm Hg, diastolic ≥90 mm Hg, or a positive response to the question, “Are you currently taking medication to lower your BP?”

Untreated, twice-told hypertension was defined as untreated individuals with BP <140/<90 mm Hg reporting that a physician told them twice that they had hypertension.

Hypertension control was defined as BP <140/<90 mm Hg for adults aged <60 years. Hypertension control was assessed at both <140/<90 and <150/<90 mm Hg for adults aged ≥60 years. BP control in diabetes mellitus and chronic kidney disease (CKD) was assessed at <140/<90 mm Hg, although goal BP for these patients was <130/<80 mm Hg to <85 mm Hg from 1997 to 2013.

Diabetes mellitus was defined by a positive response to 1 or more of the following questions: “Have you ever been told by a doctor that you have diabetes?” “Are you now taking insulin?” “Are you now taking diabetic pills to lower your blood sugar?” or a positive match between medication(s) reported or brought to the examination and known diabetes medication(s), fasting glucose ≥126 mg/dL, or glycosylated hemoglobin ≥6.5%. Serum creatinine values were adjusted to facilitate comparisons of estimated glomerular filtration rates across surveys.

Coronary heart disease was defined by a positive response to “Has a doctor ever told you that you had a heart attack?” or “Has a doctor ever told you that you had coronary heart disease?” or angina by the Rose questionnaire.

Stroke was defined by a positive response to “Has a doctor ever told you that you had a stroke?”

Congestive heart failure was determined by an affirmative response to “Has a doctor ever told you that you had congestive heart failure?”

CKD was defined by estimated glomerular filtration rate <60 mL·1.73 m⁻²·min⁻¹ or urine albumin creatinine ratio ≥30 mg/g. Serum creatinine values were adjusted to facilitate comparisons of estimated glomerular filtration rates across surveys.

Medical visits were defined by the response to the question, “How many times did you receive health care over the last year?” Responses were classified into <2 versus ≥2 visits per year.

Uninsured status is defined by a negative answer to “Are you covered by health insurance or some other kind of healthcare plan?”

A patient was considered to be a cigarette smoker if he or she answered “every day” or “some days” to “Do you now smoke cigarettes?”

ASCVD 10-year risk scores were calculated for adults aged ≥40 years who were free of clinical CVD. Individual aged ≥80 years were assigned an age of 79 years, which is the maximum allowed in the calculation. Risk scores for races other than black were calculated using white race. ASCVD 10-year risk scores were calculated for adults aged ≥60 years without clinical CVD who had untreated BPs of 140 to 149/<90 mm Hg before and after a hypothetical treatment-induced 10-mm Hg decrease in systolic BP.

Data Analysis
SAS survey procedures were used to account for NHANES complex survey design. PROC SURVEYMEANS was used to generate means and standard errors. PROC SURVEYFREQ was used to calculate proportions and standard errors. PROC SURVEYLOGISTIC was used to assess relationships between clinical variables and BP control. Taylor linearization was used for variance estimation, and domain analysis was used for subpopulation analysis because selection of subpopulations may be unrelated to sample design. For within-survey between-group comparisons, the Rao-Scott χ² test was used to test for differences in categorical variables; the Wald F test was used to assess differences in continuous variables. For between-survey within-group comparisons, t tests of weighted means were used. Values of P ≤0.01 were considered to be statistically significant.

Results
The study sample was derived as depicted in Figure I in the online-only Data Supplement. Hypertensive adults were divided into aged <60 years (younger; n=6872) and aged ≥60 years (older; n=10190) with the hypertension threshold ≥140/90 mm Hg (Table 1). Older patients were more likely than younger patients to be white, to have ≥2 healthcare visits per year; and to have diabetes mellitus, CKD, CVD, and 10-year coronary heart disease risk >20%; they were less likely to be obese and to be current smokers. Older patients had higher systolic and lower diastolic BPs and were more likely to receive antihypertensive medications but less likely to have BP controlled when treated. Lipid profiles improved for both groups. Older patients had higher values for low-density lipoprotein and non–high-density lipoprotein cholesterol in 1988 to 1994 but lower values than younger patients in 2005 to 2010.

Table 2 compares untreated individuals aged ≥60 years with BPs of 140 to 149/<90 mm Hg (mild ISH) and those aged ≥60 years with BP ≥150 mm Hg systolic or ≥90 mm Hg diastolic or treated. The untreated mild ISH group were more likely to be lean, were less likely to be obese, and had fewer healthcare visits, less diabetes mellitus, less CKD, less CVD, and lower 10-year ASCVD. Estimated 10-year CVD risk did not decrease with a-10 mm Hg decrease in systolic BP with treatment in previously untreated older adults with mild ISH.

Percentages of younger and older adults who were untreated declined, as indicated by the medications reported or brought to the examination (Table 3). In younger adults, the percentage on 1 to 2 medications rose but remained below older patients. The number of BP medications and percentages taking ≥3 antihypertensive medications increased more with time in older than in younger patients. Percentages of patients on β-blockers, renin-angiotensin system blockers (angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, direct renin inhibitors), and dihydロpyridine calcium channel blockers increased with time. Overall, diuretic use did not change, although K⁺-sparking diuretics and aldosterone antagonists declined. Nondihydropyridine calcium channel blocker use fell.

Prevalent hypertension and percentages who were aware, treated, and controlled to <140/<90 mm Hg increased for
adults aged <60 and aged ≥60 years when including (left) and excluding (right) untreated twice-told hypertensives with non-hypertensive BP (Figure 1). Older adults were more often aware of and treated for hypertension than younger adults. When treated, younger hypertensive adults were more likely to be controlled to <140/<90 mm Hg than older adults. Age-related differences in BP control, that is, the age gap, to <140/<90 mm Hg among all hypertensive adults (left side) declined with time. Age differences were not seen among traditionally defined hypertensive adults, that is, those with elevated BP.

Table 1. Characteristics of Hypertensive Patients* by Age Group in 3 NHANES Time Periods

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<td>Age ≥60 y</td>
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<td>Age ≥60 y</td>
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<td>3344</td>
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<td>23 729 382</td>
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<td>Age, y</td>
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<td>72±1</td>
<td>45±1‡</td>
<td>72±1$</td>
<td>46±1‡</td>
<td>71±1</td>
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<td>Male, %</td>
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<td>40±1</td>
<td>53±1‡</td>
<td>40±1</td>
<td>54±1‡</td>
<td>43±1</td>
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<td>Race, %</td>
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<td>68±2‡</td>
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<td>7±2</td>
<td>10±1</td>
<td>6±1I</td>
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<td>BMI, kg/m²</td>
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<td>&lt;25, %</td>
<td>22±2‡</td>
<td>33±1I</td>
<td>19±1†</td>
<td>26±1</td>
<td>17±1‡</td>
<td>24±1</td>
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<td>≥30, %</td>
<td>45±2</td>
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<td>49±1</td>
<td>36±1</td>
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<td>&lt;2</td>
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<td>22±1I</td>
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<td>73±1</td>
<td>86±1</td>
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<td>Uninsured, %</td>
<td>15±2‡</td>
<td>2±1I</td>
<td>17±1†</td>
<td>3±1I$</td>
<td>20±1‡</td>
<td>5±1I</td>
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<td>Blood pressure</td>
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<td>SBP, mm Hg</td>
<td>132±1‡</td>
<td>147±1</td>
<td>134±1‡</td>
<td>146±1</td>
<td>131±1‡</td>
<td>138±1</td>
</tr>
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<td>DBP, mm Hg</td>
<td>84±1‡</td>
<td>75±1I</td>
<td>82±1‡</td>
<td>70±1</td>
<td>78±1‡</td>
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<td>BP medications, %</td>
<td>35±1I</td>
<td>56±1I</td>
<td>46±2‡</td>
<td>66±2I</td>
<td>55±1‡</td>
<td>78±1I</td>
</tr>
<tr>
<td>&lt;140/&lt;90 mm Hg, %</td>
<td>46±2‡</td>
<td>32±1I</td>
<td>46±2‡</td>
<td>37±1I</td>
<td>56±1I</td>
<td>53±1I</td>
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<td>Lipids</td>
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<tr>
<td>HTa, %</td>
<td>74±2‡I</td>
<td>94±1I</td>
<td>84±1‡</td>
<td>97±1</td>
<td>84±1‡I</td>
<td>97±1</td>
</tr>
<tr>
<td>HTb, %</td>
<td>26±2I</td>
<td>6±1I</td>
<td>16±1†</td>
<td>3±1</td>
<td>16±1†</td>
<td>3±1I</td>
</tr>
<tr>
<td>LDL, mg/dL</td>
<td>134±2I</td>
<td>140±1I</td>
<td>124±2§</td>
<td>121±1I</td>
<td>118±1I</td>
<td>110±1I</td>
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<tr>
<td>Non-HDL, mg/dL</td>
<td>167±1I</td>
<td>176±1I</td>
<td>159±1§</td>
<td>156±1I</td>
<td>154±1I</td>
<td>141±1I</td>
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<td>Lipid medication,%</td>
<td>4±1I</td>
<td>7±1I</td>
<td>15±1†I</td>
<td>30±1I</td>
<td>21±1I</td>
<td>47±1I</td>
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<td>Statin, %</td>
<td>3±1I</td>
<td>4±1I</td>
<td>13±1†I</td>
<td>27±1§</td>
<td>19±1§I</td>
<td>44±1I</td>
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<td>Other risk/disease, %</td>
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<tr>
<td>Diabetes mellitus,%</td>
<td>14±1‡</td>
<td>24±1</td>
<td>15±1§$</td>
<td>24±1I</td>
<td>19±1I</td>
<td>31±1</td>
</tr>
<tr>
<td>Smoker</td>
<td>29±1‡</td>
<td>13±1</td>
<td>25±1†</td>
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<td>27±1‡</td>
<td>10±1§</td>
</tr>
<tr>
<td>CKD, %</td>
<td>4±1I</td>
<td>21±1§</td>
<td>5±1I</td>
<td>25±1</td>
<td>6±1</td>
<td>25±1I</td>
</tr>
<tr>
<td>CKD, %</td>
<td>13±1I</td>
<td>36±1</td>
<td>14±1§</td>
<td>38±1</td>
<td>15±1I</td>
<td>37±1</td>
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<tr>
<td>ASCVD, %</td>
<td>10±1I</td>
<td>24±1§</td>
<td>11±1‡</td>
<td>30±1</td>
<td>12±1I</td>
<td>29±1I</td>
</tr>
</tbody>
</table>

*Includes twice-told hypertensive patients with nonhypertensive BP on examination.
†P<0.01, ‡P<0.001 between groups within NHANES periods: symbols in column 1 represent comparison with column 2.
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≥140/≥90 mm Hg or on treatment (right side). Older hypertensive adults had higher BP control rates to <150/<90 mm Hg than younger hypertensive adults to <140/<90 mm Hg in 1999 to 2004 and 2005 to 2010.

Clinical variables independently related to BP control to <140/<90 mm Hg in younger and older adults for NHANES 1988 to 2010 are shown in Figure 2. For younger adults, BP control increased with age, ≥2 versus <2 healthcare visits annually, with versus without health insurance, statin therapy versus no statin therapy, and with versus without clinical CVD. Hypertension control was lower in men than women and in black and Hispanic than white adults.

BP control declined with increasing age in older adults, which was significantly different from younger patients. In

### Table 2. Characteristics of Hypertensive Patients* Aged ≥60 Years by BP Threshold in 3 NHANES Periods

<table>
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<tr>
<td>≥150/&lt;90</td>
<td>20897969</td>
<td>25862927</td>
<td>30341735</td>
</tr>
<tr>
<td>140–149/&lt;90</td>
<td>2831413</td>
<td>2802709</td>
<td>2534265</td>
</tr>
</tbody>
</table>

Proportion, %

Age, y

Male sex, %

Race

White

Black

Hispanic

BMI, kg/m²

<25, %

≥30, %

Visits per year, %

<2

≥2

Uninsured, %

BP, mm Hg

SBP, mm Hg

DBP, mm Hg

BP medications, %

BP <140/90 mm Hg, %

HTa, %

HTb, %

LDL, mg/dL

Non-HDL, mg/dL

Cholesterol mediation, %

Statin, %

Diabetes mellitus, %

Smoker, %

CKD₁, %

CKD₂, %

ASCVD₁₀ risk

ASCVD₁₀MMHG, %

Patients aged ≥80 years were assigned age 79 years. Data are presented as mean±SE. SE >0 and <1.5=1. ASCVD₁₀ risk indicates atherosclerotic 10-year cardiovascular disease risk; ASCVD₁₀MMHG risk after theoretical 10-mm Hg reduction of BP on treatment in adults aged ≥60 years with previously untreated BP 140 to 149/<90 mm Hg; BMI, body mass index; BP, blood pressure; CKD₁, estimated glomerular filtration rate <60 mL·1.73 m⁻²·min⁻¹ or ratio of albumin to creatinine ≥300 mg/g; CKD₂, estimated glomerular filtration rate <60 mL·1.73 m⁻²·min⁻¹ or ratio of albumin to creatinine ratio ≥30 mg/g; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein cholesterol; NHANES, National Health and Nutrition Examination Survey; and SBP, systolic blood pressure.

*Includes twice-told hypertensive patients with nonhypertensive BP on examination.

†P<0.01, ‡P<0.001 between groups within NHANES periods: symbols in column 1 represent comparison with column 2.

older adults, BP control was lower in Hispanic than white adults and in women than men. Hypertension control improved with increasing body mass index, also different from younger adults and in women than men. Hypertension control improved with an increase in number of antihypertensive medications taken increased. With

### Discussion

The main objective was to assess time-dependent changes in hypertension control in adults aged <60 and aged ≥60 years. At goal BP of <140/<90 mm Hg, hypertension control improved for all hypertensive adults. The age gap in hypertension control between adults aged <60 years and those aged ≥60 years narrowed from 14.1% in 1988 to 1994 to 2.8% in 2005 to 2010 (Figure 1). With a less stringent, evidence-based goal of <150/<90 mm Hg in older adults,14 control rose from 48.8% to 69.9% and exceeded control to <140/<90 mm Hg among younger adults in 1999 to 2004 and 2005 to 2010.

A key secondary objective was to identify clinical factors associated with BP control in younger and older adults. Untreated hypertension declined with time in both age groups, and the number of antihypertensive medications taken increased. With hypertension defined as BP ≥140/≥90 mm Hg or on treatment, untreated hypertension fell from 53.3% to 35.1% in younger and 40.8% to 20.3% in older adults from 1988 to 1994 to 2005 to 2010. The number of antihypertensive medications and the percentage taking ≥3 different BP medications increased in both age groups but more in older than in younger adults (Table 3). These data are consistent with prior evidence that improved BP control with time largely reflects more intensive pharmacotherapy because weight increased and diets became less healthy29,30 and that more antihypertensive medication is required to achieve control in older patients in whom ISH predominates than in younger patients.8,9 Improved hypertension control, especially among treated patients, also suggests that medication adherence improved from low levels reported previously.31

### Table 3. Number and Class of BP Medications Reported By Hypertensive Patients* Aged <60 Versus ≥60 Years in 3 NHANES Time Periods

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<tbody>
<tr>
<td>0 BP medications, %</td>
<td>67±2†</td>
<td>54±2†</td>
<td>46±1†</td>
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<tr>
<td>1–2 BP medications, %</td>
<td>29±2t</td>
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<tr>
<td>≥3 BP medications, %</td>
<td>4±0l</td>
<td>8±1</td>
<td>10±1l</td>
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</table>

*Patients aged ≥80 years were assigned age 79 years. Data are presented as mean±SE. Means and standard errors >0 and <1.5 are presented as 1. BP indicates blood pressure; CCB, calcium channel blocker; d, dihydropyridine; K-spar/aldo ant, potassium-sparing diuretic or aldosterone antagonist diuretic; nd, nondihydropyridine; NHANES, National Health and Nutrition Examination Survey; and RAS blocker, renin-angiotensin system blocker (angiotensin-converting enzyme inhibitors/angiotensin receptor blockers/direct renin inhibitors).<ref>

†P<0.01, ‡P<0.001 between groups within NHANES periods: symbols in column 1 represent comparison with column 2.
¶Not significant.

Patients aged ≥80 years were assigned age 79 years. Data are presented as mean±SE. Means and standard errors >0 and <1.5 are presented as 1. BP indicates blood pressure; CCB, calcium channel blocker; d, dihydropyridine; K-spar/aldo ant, potassium-sparing diuretic or aldosterone antagonist diuretic; nd, nondihydropyridine; NHANES, National Health and Nutrition Examination Survey; and RAS blocker, renin-angiotensin system blocker (angiotensin-converting enzyme inhibitors/angiotensin receptor blockers/direct renin inhibitors).<ref>

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†P<0.01, ‡P<0.001 between groups within NHANES periods: symbols in column 1 represent comparison with column 2.
¶Not significant.
Figure 1. The clinical epidemiology (prevalence [A], aware [B], treated [C], controlled/treated [D], and controlled [E]) is shown for hypertensive adults aged <60 and ≥60 years. For adults aged ≥60 years, data are provided for hypertension defined by ≥140 or ≥150 mm Hg systolic or ≥90 mm Hg diastolic. Control was defined as <140/<90 mm Hg for adults aged <60 years and <140/<90 and <150/<90 mm Hg for adults aged ≥60 years. **Left** side includes adults told twice that they were hypertensive but with nonhypertensive blood pressure on examination. The **right** side excludes those twice-told hypertensive adults. *P<0.01, †P<0.001 between groups within National Health and Nutrition Examination Survey (NHANES) periods; symbols on the **left** of ≥60 years of age (140/90 mm Hg), (150/90 mm Hg) represent comparison with those aged <60 years; ‡P<0.01, § P<0.001 represent significant changes within groups over time from 1988 to 1994 to 2005 to 2010.
The large changes in antihypertensive pharmacotherapy, especially in older adults, imply significant changes over time in patients’ and their clinicians’ perceptions of the importance of controlling systolic hypertension. Survey data reported a decade ago indicated that older Americans were generally less aware of and concerned about risks of elevated systolic than diastolic BP. Around the turn of the millennium, ≈40% of physicians were reluctant to initiate or intensify antihypertensive therapy for systolic BP of 140 to 159 mm Hg (stage 1). These attitudes were time concordant with a very low rate of intensifying antihypertensive treatment for uncontrolled stage 1 ISH.

Advancing age is generally associated with a decline in hypertension control, especially as a percentage of treated adults controlled. In this report, increasing age was associated with better hypertension control in adults aged <60 years and worse control in adults aged ≥60 years (Figure 2). The declining control with age in older adults likely reflects progressive increases in vascular stiffness, although present data suggest that therapeutic intensification is reducing the age gap in hypertension control (Table 3 and Figure 1).

Men were less likely than women to have controlled hypertension at aged <60 years but more likely to have hypertension controlled when aged ≥60 years (Figure 2). These data coincide with reports that younger men are less likely to be aware of and treated for hypertension than younger women. In contrast, women are more likely than men to have treatment-resistant hypertension, which occurs mainly at older ages. Black and Hispanic adults were less likely than whites to have controlled hypertension, which reflects more treatment-resistant hypertension in blacks and lower treatment rates in Hispanics.

As noted previously, access to care, assessed by healthcare visit frequency and healthcare insurance, was related to BP control in younger and older adults. Although insurance status and visit frequency were independent variables in the multivariable regression, uninsured adults, both low and high income, visit healthcare providers less frequently than insured adults.

In both age groups, statin use was associated with better hypertension control (Figure 2). Statins are associated with lower BP, which may be explained by decreases in

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**Figure 2.** The multivariable odds ratios and 95% confidence intervals depicting the independent relationship of various modifiable and nonmodifiable clinical variables to blood pressure (BP) control for National Health and Nutrition Examination Survey (NHANES) 1988 to 2010 are shown, with separate symbols for younger and older hypertensive adults. **Top.** The independent relationship of several modifiable (eg, visit frequency, insurance) and nonmodifiable (eg, age, race, sex) variables to BP control. **Bottom.** The independent relationship of various classes of antihypertensive medications to hypertension control with adjustment for number of BP medications and key nonmodifiable variables. Odds ratios and 95% confidence intervals are shown on the right. BMI indicates body mass index; CKD, chronic kidney disease defined as estimated glomerular filtration rate <60 mL·1.73 m−2·min−1 or ratio of albumin to creatinine ≥300 mg/g; CVD, cardiovascular disease; DCCB, dihydropyridine calcium channel blocker; DM, diabetes mellitus; NDCCB, nondihydropyridine calcium channel blocker; and RAS, renin-angiotensin system blocker. Significant differences in odds ratios between age groups are indicated as *P*<0.01 and †P<0.001.
angiotensin-I receptors and pressor responses to angiotensin II. In a large trial, patients randomized to atorvastatin versus placebo were less likely to have treatment-resistant hypertension; that is, they required a fourth medication to achieve hypertension control.

Prevalent CVD was associated with better hypertension control in both age groups, which suggests that patients and clinicians are more attentive to hypertension control when cardiovascular risk is higher. The positive relationship of hypertension control to CKD in older adults may reflect a similar rationale and a lower BP goal for CKD patients since 1997, although CKD is linked to treatment-resistant hypertension.

Most antihypertensive medication classes were associated with better hypertension control (Figure 2). In older and younger adults, renin-angiotensin system blockers, for example, angiotensin-converting enzyme inhibitors and angiotensin receptor blockers, dihydropyridine calcium channel blockers, and diuretics, were independently associated with hypertension control. These 3 antihypertensive medication classes are also recommended as the first 3 classes used to treat hypertension, singly and in combination, in contemporary guidelines. In adults aged <60 years, β-blockers were also associated with hypertension control. β-Blockers and renin-angiotensin system blockers were more strongly associated with hypertension control in younger than older adults. These findings are generally, albeit imperfectly, aligned with prior reports. The lack of association between hypertension control and sympatholytics and vasodilators may reflect their use as fourth- and fifth-line add-on therapy in uncontrolled patients because these agents lower BP.

The third objective was to assess the impact of a theoretical 10-mmHg systolic BP reduction with treatment on ASCVD 10-year risk in older adults with untreated mild ISH, that is, BP of 140 to 149/<90 mmHg. ASCVD risk did not decline when systolic BP was reduced 10 mmHg on treatment in this group (Table 2). Major ISH studies included only patients with stage 2 disease, that is, systolic BP ≥160/<90 mmHg, and attained mean systolic BP of 143 to 151 mmHg. Two studies achieved mean on-treatment systolic BP of ≤143 mmHg, and both documented outcome benefits compared with placebo-controlled patients with systolic BP >150 mmHg. Two less frequently cited studies of stage 2 ISH randomized patients to goal systolic BP of <140 versus 140 to <150 mmHg. Neither study showed significant reductions in predefined primary outcomes with lower systolic goals, although neither study was powered to detect differences of ≤25%. Available data support evidence-based recommendations for goal systolic BP <150 mmHg in patients aged ≥60 years with ISH.

The proportion of adults with untreated mild ISH is relatively small and appears to be declining with time (Table 2), which suggests that clinicians are treating a growing segment of this group. Although additional work is required to define optimal BP for reducing CVD, especially among older adults, lower BP is not always better for coronary heart disease outcomes and total mortality, although stroke is reduced.

Limitations of this report include cross-sectional data from a single examination and lack of out-of-office BP data, which could lead to misclassification of hypertension status and control in some individuals. Control rates reported by our group exceed those in some previous reports. Unlike those reports, we excluded the first BP reading, which is typically higher, when calculating mean systolic and diastolic BPs, as recommended in the NHANES reporting guidelines. Second, we included untreated, twice-told hypertensive patients with non-hypertensive BP on examination as hypertensive, consistent with other reports and estimates of prevalent hypertension.

The key findings include the following. First, the relatively large age-related gap in hypertension control between younger and older adults to <140/<90 mmHg in 1988 to 1994 was reduced in 1999 to 2004 and essentially eliminated by 2005 to 2010. Eliminating the age gap in hypertension control likely reflects changes in provider and patient perceptions of the risk of ISH, leading to more intensive pharmacotherapy, especially in older adults. Second, when an evidence-based goal of <150/<90 mmHg in older adults with ISH is applied, their hypertension control rates exceed control in younger adults at <140/<90 mmHg from 1999 to 2010. Third, patients and their healthcare providers are achieving higher hypertension control rates in patients at greater risk, including those with clinical CVD, which suggests greater attention to hypertension control when absolute clinical risk is higher. Fourth, at least biannual visits and prescribing statins as recommended in the current guidelines to younger and older hypertensive adults could further raise BP control and reduce clinical complications. Finally, lowering systolic BP 10 mmHg on treatment in previously untreated older adults with a BP of 140 to 149/<90 mmHg does not improve predicted 10-year ASCVD risk.

Clinical trials not specifically designed to address treatment benefits of mild ISH indicate that stroke is reduced with systolic BPs ≤140 mmHg among patients with a mean age >60 years. Older hypertensive adults and their clinicians showed evidence of growing attention to management guidelines and goals in effect during 1999 to 2010 while awaiting clinical trial evidence of benefit for a systolic BP goal <140 mmHg in patients aged ≥260 years with untreated BP of 140 to 149/<90 mmHg.

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Disclosures
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References


**CLINICAL PERSPECTIVE**

Recent reports emphasize challenges in hypertension control and implicate the healthcare system generally and clinicians specifically for limited success. Although improvement in hypertension control is needed, progress in hypertension control appears to be underappreciated. From 1988 to 2010, blood pressure control to <140/<90 mm Hg in adults aged ≥60 years improved more than in younger adults as the age gap in control narrowed from 14% to 3%. In fact, nearly 70% of all older adults with hypertension attained an evidence-based blood pressure goal of <150/<90 mm Hg. Patients and their clinicians are to be commended for recognizing the benefits of better blood pressure control and taking action to initiate, intensify, and adhere to antihypertensive therapy, which underlies remarkable progress. The data suggest that ensuring that hypertensive patients have at least biannual healthcare visits and receive statins according to current guidelines could contribute to even better hypertension blood pressure control and fewer cardiovascular events in the years ahead. Further study to clarify the optimal systolic blood pressure goal for older adults could reduce uncertainty, leading to even better management and outcomes.
Closing the Gap in Hypertension Control Between Younger and Older Adults: National Health and Nutrition Examination Survey (NHANES) 1988 to 2010
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**SUPPLEMENTAL FIGURE 1:**

**Figure Legend:** The process for deriving the study sample of adults <60 and ≥60 years old with hypertension is depicted. As shown, there were: (1) 6,782 adults <60 years old with hypertension (2) 9,187 adults ≥60 years old with hypertension defined as blood pressure ≥150 systolic and/or ≥90 mm Hg diastolic and/or on treatment and (3) 1,003 adults ≥60 years old who were untreated and had blood pressure 140 – 149/<90, i.e., not hypertensive at the 150/90 cutpoint.