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## Therapeutic Inertia Is an Impediment to Achieving the Healthy People 2010 Blood Pressure Control Goals

Eni C. Okonofua, Kit N. Simpson, Ammar Jesri, Shakaib U. Rehman,  
Valerie L. Durkalski, Brent M. Egan

**Abstract**—Therapeutic inertia (TI), defined as the providers' failure to increase therapy when treatment goals are unmet, contributes to the high prevalence of uncontrolled hypertension ( $\geq 140/90$  mm Hg), but the quantitative impact is unknown. To address this gap, a retrospective cohort study was conducted on 7253 hypertensives that had  $\geq 4$  visits and  $\geq 1$  elevated blood pressure (BP) in 2003. A 1-year TI score was calculated for each patient as the difference between expected and observed medication change rates with higher scores reflecting greater TI. Antihypertensive therapy was increased on 13.1% of visits with uncontrolled BP. Systolic BP decreased in patients in the lowest quintile of the TI score but increased in those in the highest quintile ( $-6.8 \pm 0.5$  versus  $+1.8 \pm 0.6$  mm Hg;  $P < 0.001$ ). Individuals in the lowest TI quintile were  $\approx 33$  times more likely to have their BP controlled at the last visit than those in highest quintile (odds ratio, 32.7; 95% CI, 25.1 to 42.6;  $P < 0.0001$ ). By multivariable analysis, TI accounted for  $\approx 19\%$  of the variance in BP control. If TI scores were decreased  $\approx 50\%$ , that is, increasing medication dosages on  $\approx 30\%$  of visits, BP control would increase from the observed 45.1% to a projected 65.9% in 1 year. This study confirms the high rate of TI in uncontrolled hypertensive subjects. TI has a major impact on BP control in hypertensive subjects receiving regular care. Reducing TI is critical in attaining the Healthy People 2010 goal of controlling hypertension in 50% of all patients. (*Hypertension*. 2006;47:345-351.)

**Key Words:** population ■ antihypertensive agents ■ blood pressure monitoring ■ compliance ■ blood pressure ■ hypertension, arterial

Hypertension affects 31.3% of adults or  $\approx 65$  000 000 people in the United States.<sup>1</sup> Blood pressure (BP) control rates to the goal of  $< 140/90$  mm Hg are low at 31% of all hypertensives and 53% of those on therapy based on the National Health and Nutrition Examination Survey 1999–2000.<sup>2,3</sup> Despite an increase in the number and tolerability of antihypertensive medications, goal BP has been difficult to attain. Clinical trials, including the Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack trial,<sup>4</sup> with 66% control rates and the Controlled Onset Verapamil Investigation of Cardiovascular Endpoints study<sup>5</sup> with 70% control rates have shown that the BP control rates reported in national data can be substantially improved. Of note, the majority of uncontrolled hypertensive subjects in the United States are older individuals with systolic BP (SBP) 140 to 159 mm Hg who are seen an average of 6 times annually in a primary care setting.<sup>6</sup>

Even with substantial reductions in the number of unaware and untreated hypertensive patients, controlling BP in  $\geq 70\%$  of treated patients is a vital component of reaching the Healthy People 2010 goal of controlling hypertension in 50% of all affected patients.<sup>7</sup> Hypertension control rates nearly

tripled from 10% in 1976–1980 to 29% in 1988–1991.<sup>8</sup> The improvements in hypertension control coincided temporally with a large decline in the age-adjusted rates for stroke and coronary heart disease (CHD).

Unfortunately, BP control rates have changed little in the past 15 years, especially in women. Patient factors, such as compliance,<sup>9,10</sup> knowledge,<sup>11</sup> and lack of insurance,<sup>12</sup> and system factors, such as limited access to care and medications<sup>13</sup> and lack of appointment reminders,<sup>14</sup> have been cited for the low rates of BP control. Of note, BP control remains suboptimal in systems such as the Veterans Administration where financial barriers to health care are less.<sup>15,16</sup> Physician factors, such as therapeutic inertia (TI), that is, failure of providers to begin new medications or increase dosages of existing medications when an abnormal clinical parameter is recorded, are becoming more evident. TI represents a significant barrier to better hypertension control. TI impacts not only control of BP but of other chronic diseases, including diabetes mellitus and hyperlipidemia.<sup>17–24</sup>

Although data suggest that TI contributes to the high prevalence of uncontrolled hypertension, the quantitative impact is not clear. This article examines the impact of TI on

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failing to control hypertension in  $\geq 70\%$  of treated patients. The 70% control rate in hypertensive patients has been attained in clinical trials and represents a vital component of attaining the Health People 2010 goal of controlling BP to  $<140/90$  mm Hg in 50% of all patients.<sup>5,7</sup> To address this important issue, we examined outpatient medical data from hypertensive patients who were seen on  $\geq 4$  outpatient visits during 2003 by physicians participating in the Hypertension Initiative medical record audit and feedback program.<sup>15</sup> We evaluated demographic and other factors that might impact TI, as well as the impact of TI on BP control.

## Methods

### Study Design

This retrospective cohort study used existing data obtained from clinical sites participating in the Hypertension Initiative. The research use of the database by the initiative has been reviewed and approved by the institutional review committee at the Medical University of South Carolina, and the procedures followed were in accordance with institutional guidelines. Each clinical site signed a business associate agreement that defines the terms and conditions of the collaboration and addresses the treatment, payment, and operations, as well as the research components of the Health Insurance Portability and Accountability Act.

### The Database

In 2003, there were 62 practices from South Carolina, North Carolina, and Georgia contributing information on 49 101 hypertensive patients to the database. Data are obtained both electronically or by a card method and then transferred into the database. Consecutive patients are entered into the database, which is audited periodically for accuracy and completion. The database has information from community clinics, veteran affairs primary care clinics, residents (physicians in training) clinics, and solo and group practices. The database includes patient demographics, comorbid risk factors, for example, diabetes mellitus and hypercholesterolemia, and target organ damage, such as cardiovascular disease (CVD), chronic heart failure (CHF), CHD, stroke, transient ischemic attack, and nephropathy as defined by the providers. Other variables in the database include medication names and dosages at each visit and BP measurements. Only 1 BP measurement per visit is recorded in the database, with the last BP measurement in the seated position receiving the highest priority.

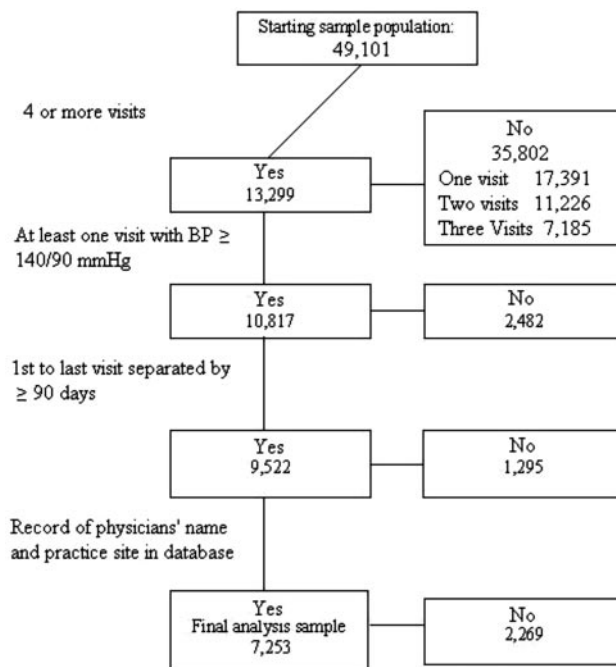
### Identification of Subjects

Analysis was limited to a 1-year period from January 1 to December 31, 2003. Subjects were included in the analysis if they met all of the following criteria (Figure 1): (1)  $\geq 4$  recorded visits during the 2003 calendar year; (2)  $\geq 1$  visit with elevated BP recorded during the year; (3) first and last visits separated by  $\geq 3$  months; and (4) a record of the patient's physician and practice site.

### Definition of Terms

BP at each visit was classified as controlled if the values were  $<140$  mm Hg SBP and  $<90$  mm Hg diastolic (DBP). A visit with TI was defined as one in which an elevated BP, that is,  $\geq 140$  mm Hg SBP and/or  $\geq 90$  mm Hg DBP, was recorded with no increase in antihypertensive medications.<sup>18</sup> An increase in antihypertensive medications was defined either as the addition of a new antihypertensive medication or an increase in the dose of an existing antihypertensive medication without discontinuing or reducing the dose of other antihypertensive medications. A change within a class to an equivalent dose was classified as no change. A decrease in the number of antihypertensive medications or the dose of a medication was also classified as no change.

Database variables included in the analyses were demographics (age, race, and sex), SBP, DBP, and cardiovascular risk factors,



**Figure 1.** Criteria for inclusion into the analysis sample are depicted above. Fifteen percent of the patients in the database formed the analysis sample; most of the patients were disqualified, because they had  $<4$  visits as shown in the flow diagram.

including diabetes mellitus, hypercholesterolemia, tobacco abuse, and family history of CVDs. Other variables are physician practice type and evidence of end organ damage including a history of stroke, CVD, CHF, CHD, and nephropathy. Derived variables included the number of antihypertensive medications the patient was receiving on each visit, the presence or absence of TI on each visit, and the 1-year TI score for each patient.

The 1-year TI score was obtained using a modification of the method used by Berlowitz et al<sup>16</sup> to calculate the intensity of therapy as the difference between the expected medication change rate (number of visits with elevated BP/total number of visits) and the observed medication change rate (actual number of visits in which medications were increased/total number of visits). This method uses a scoring range from  $-1$  to  $+1$  (higher scores indicating greater TI). All of the visits were used to calculate the TI score except the last, because the effects of medication adjustment at the last visit cannot be determined. As an example, a patient with 5 visits during the year excluding the last visit, with elevated BP on 4 of those visits, has an expected medication change rate of  $4/5=0.8$ . If medication changes were made on 2 of the visits, then the observed medication change rate is  $2/5$  and the TI score is  $4/5-2/5=0.4$ , that is, medication changes were made in 40% fewer visits than expected. To determine the effects of changing medications more often than expected, TI score was also calculated after converting visits in which BP was normal and therapy intensified to visits in which no changes were made.

### Statistical Analysis

Data are reported as mean  $\pm$  SEM. Univariate models were used to determine the associations between TI at each visit and comorbid risk factors and demographic variables, as well as between the 1-year TI score, changes in BP from first to last visits, and BP control at the last visit. Random-effects multivariable regression models were used for analyses to account for the correlation between patients seeing the same physician and physicians within the same practice. Different multiple regression models were developed to determine the impact of the 1-year TI scores on changes in BP between the first and last visits and BP control rates at the last visit. A mixed-effects

logistic regression model was developed to determine the impact of a visit with TI on BP control at the subsequent visit, adjusting for prespecified covariates. A similar model was used to predict the likelihood of a visit resulting in TI based on variables collected at that visit. The 1-year patient TI scores were divided into quintiles, and comparisons were made between those in the lowest and highest groups. All of the analyses were conducted using SAS version 9.1.

## Results

There were 49 101 individuals in the year of interest recording 151 171 visits. Of these individuals, 7253 subjects seen by 168 physicians at 44 sites met the criteria for inclusion into the analysis sample (Figure 1). Characteristics of patients in the database in 2003 and in the analyzed sample are shown in Table 1. The mean SBP and DBP of patients in the analyzed sample was  $142.4 \pm 0.2/80.3 \pm 0.1$  mm Hg at the first visit and  $139.6 \pm 0.2/77.9 \pm 0.1$  mm Hg at the last visit. The reduction in mean SBP and DBP coincided with an improvement in the proportion of patients with hypertension controlled to  $<140/90$  mm Hg from 39.5% at the beginning to 45.1% at the end of 2003. The subset of 7253 subjects included in the analysis had an average of  $6.4 \pm 0.03$  medical visits during the year. Elevated BP was recorded at 55% of visits (expected medi-

**TABLE 1. Comparison of Characteristics Between the Patients Excluded From the Analysis and Those in the Analysis Sample\***

Variables	Total HISC	Excluded Sample	Analysis Sample
No.	49 101	41 848	7253
Age, y	$61.6 \pm 0.1$	$61.3 \pm 0.07$	$63.4 \pm 0.2$
Sex, female, %	41.9	41.3	45.3
Race, %			
White	43.8	43.3	47.0
Black	31.5	32.1	28.1
Unknown	24.7	24.7	25.0
No. of medications (visit 1)	$1.5 \pm 0.01$	$1.5 \pm 0.01$	$1.5 \pm 0.01$
No. of medications (last visit)	$1.5 \pm 0.01$	$1.5 \pm 0.01$	$1.6 \pm 0.01$
Diabetes mellitus, %	34.1	32.9	41.5
Hypercholesterolemia, %	58.9	58.1	63.7
Nephropathy, %	9.7	8.9	14.4
Tobacco, %	7.7	8.0	5.8
CVD, %	41.7	40.2	51.0
CHF, %	7.6	7.1	11.1
SBP change, mm Hg	$-2.2 \pm 0.08$	$-2.1 \pm 0.08$	$-2.8 \pm 0.3$
DBP change, mm Hg	$-1.5 \pm 0.01$	$-1.2 \pm 0.04$	$-2.4 \pm 0.1$
BP visit 1 $<140/90$ , %	46.7	47.9	39.5
BP last visit $<140/90$ , %	51.8	52.9	45.1
Practice type, %			
CH	8.8	9.0	8.1
FR	4.8	4.9	4.4
GP	51.0	49.5	60.0
SP	2.1	2.3	1.1
VA	33.2	34.4	26.4

HISC indicates hypertension initiative of South Carolina; CH, federally funded community (family) health center; FR, family residency training program; GP, group practice; SP, solo practice.

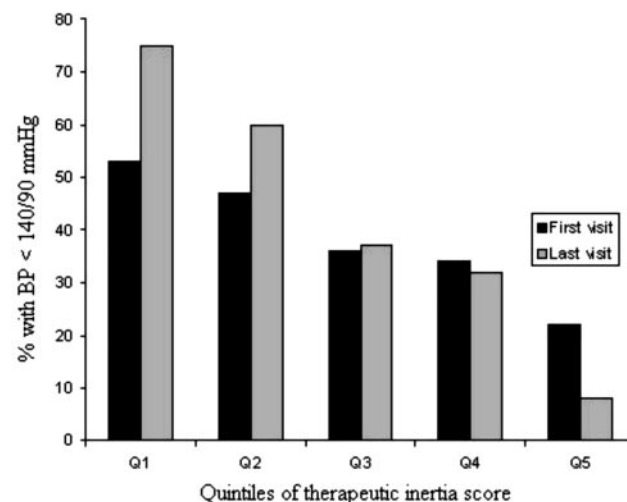
\*Plus-minus values are mean  $\pm$  SEM.

cation change rate of 0.55), and medications were changed on 10.9% of visits (observed medication change rate of 0.11). This resulted in a mean TI score of  $+0.44 \pm 0.19$ , that is, medications were changed in 44% fewer visits than expected. Medications were changed on only 13.1% of visits with an elevated BP.

The estimated intracluster correlation coefficient of the TI score is 0.04 (95% CI, 0.027 to 0.053), indicating that the TI scores for subjects seen by the same physician (within cluster) were more similar than TI scores between subjects seen by different physicians (between cluster). The intracluster correlation coefficient is accounted for in the analyses.

Subjects were subdivided into quintiles based on the 1-year TI scores. Figure 2 shows a decreasing improvement in BP control rates as TI scores increased from quintiles 1 to 5. The average TI score in quintile 1 was  $0.10 \pm 0.002$  and in quintile 5 was  $0.73 \pm 0.002$  (Table 2). From the first to last visits, BP decreased by  $6.8 \pm 0.5/4.4 \pm 0.4$  mm Hg for those in quintile 1, whereas those in quintile 5 had an increase in SBP of  $1.8 \pm 0.6$  and a decrease in DBP of  $0.7 \pm 0.3$  mm Hg. This change in BP resulted in an increase in control rates from 53.0% to 75.5% for those in quintile 1 and a decrease from 22.2% to 7.7% for those in quintile 5. Unadjusted analysis showed that individuals in the lowest quintile of TI score were more likely to have their BP controlled at the last visit (odds ratio, 35.0; 95% CI, 27.4 to 45.8;  $P < 0.0001$ ). After controlling for initial BP and other selected covariates, the odds of having a BP  $<140/90$  mm Hg at the last visit for quintile 1 compared with 5 was 32.7 (95% CI, 25.1 to 42.6;  $P < 0.0001$ ).

Significant positive predictors of a visit with TI (Table 3) include patients with BP readings in the stage 1 as compared with stage 2 hypertension range and patients on fewer antihypertensive medications. Other positive predictors of a visit with TI include older age, patients with diabetes mellitus, hypercholesterolemia, and CHF or CVD. Ethnicity was not a significant determinant of TI, and no differences in TI score were found



**Figure 2.** Effects of TI score on blood pressure control rates are depicted. The TI scores were divided into quintiles with those in quintile 1 having the least TI. BP control ( $<140/90$  mm Hg) rates at the first visit compared with the last visit are shown for each quintile of TI score.  $P$  value for trend  $< 0.0001$ .

**TABLE 2. Comparison of Characteristics Between the Lowest and Highest Quintiles of Therapeutic Inertia Score\***

Variables	Quintile 5	Quintile 1	P Value†
No.	1310	1892	
TI score	0.73±0.002	0.10±0.002	<0.0001
Age, y	65.5±0.4	62.2±0.2	<0.0001
Sex, female, %	47.3	44.8	0.010
Race, %			
White	46.6	49.6	
Black	27.7	26.9	
Unknown	25.7	23.5	0.5569
No. of medications (visit 1)	1.6±0.04	1.5±0.05	0.003
No. of medications (last visit)	1.4±0.03	1.8±0.05	<0.0001
Diabetes mellitus, %	46.4	42.9	0.1857
Hypercholesterolemia, %	64.9	64.3	0.3412
Nephropathy, %	14.1	14.3	0.6476
Tobacco, %	4.1	6.6	0.0007
CVD, %	51.7	54.3	0.4493
CHF, %	10.6	14.7	<0.0001
SBP change, mm Hg,	+1.8±0.6	-6.8±0.5	<0.0001
DBP change, mm Hg,	-0.7±0.3	-4.4±0.4	<0.0001
BP visit 1 <140/90, %	22.2	53.0	<0.0001
BP last visit <140/90, %	7.7	75.5	<0.0001

\*Plus-minus values are mean±SEM.

†Analysis by cluster adjusted  $\chi^2$ .

when comparing patients seen at Veterans Affairs (VA) clinics to non-VA clinics.

Unadjusted analysis showed that the TI score was significantly and negatively correlated with changes in SBP from the first to last visits ( $\rho = -0.14$ ;  $P < 0.0001$ ), as well as DBP ( $\rho = -0.11$ ;  $P < 0.0001$ ) and BP control at the last visit (odds ratio, 0.824;  $P < 0.0001$ ). While controlling for clustering and covariates (Table 4), a 0.1 U increase in the TI score resulted in less decrease in SBP of  $3.14 \pm 0.10$  mm Hg ( $P < 0.0001$ )

and DBP of  $1.03 \pm 0.08$  mm Hg ( $P < 0.0001$ ) from the first to last visits. Because the mean TI score was +0.44, TI in 2003 accounted for an estimated 13.8 mm Hg higher SBP and 4.5 mm Hg higher DBP than if there were no TI.

Other factors that were associated with significantly smaller reductions in SBP include black race, older age, diabetes mellitus, and tobacco use. Conversely, diabetes mellitus, nephropathy, CVD, and older age were associated with larger decreases in DBP. Although numerous factors were significantly associated with changes in SBP and DBP, of all of the variables included in the model, TI score, SBP at the first visit, and tobacco use were significantly and negatively correlated with BP control (Table 4). Higher baseline SBP and DBP were associated with a greater decline in BP values, which probably reflects, in part, the phenomenon of regression toward the mean<sup>25</sup> in addition to the lower rates of TI observed with higher BP readings.

Analysis using data from visits with elevated BP showed that failure to intensify therapy at a single visit resulted in a significantly smaller decline in SBP (2.6 mm Hg;  $P < 0.0001$ ) and DBP (0.9 mm Hg;  $P = 0.01$ ) at the subsequent visit compared with those whose therapy was intensified. The difference in 2.6/0.9 mm Hg, however, did not result in a statistically significant difference in BP control over just 1 follow-up visit. The TI score calculated over the 1-year period accounted for  $\approx 8.0\%$  of the change in SBP and 3.4% of the change in DBP between the first and last visits. Combining both parameters to determine the effects on BP control at the last visit, TI accounted for  $\approx 19\%$  of the variability in BP control. Repeating all of the analyses with the TI score calculated after adjusting visits in which BP was recorded as normal and medication changes were made did not significantly alter the result.

## Discussion

This study confirms that BP control rates are lower in clinical practice than in contemporary clinical trials and that the rate of TI is high. Antihypertensive therapy was not intensified at

**TABLE 3. Logistic Model to Predict the Probability That a Visit Will Result in Therapeutic Inertia**

Variables	Reference	Odds Ratio	95% CI	P Value
BP, stage 2	Stage 1	0.600	0.547 to 0.658	<0.0001
Race				
Black	White	0.984	0.872 to 1.111	0.9954
Unknown		0.968	0.863 to 1.086	0.5799
Age		1.110	1.070 to 1.150	<0.0001
Sex, male	Female	0.965	0.876 to 1.064	0.4761
No. of medications		0.523	0.505 to 0.541	<0.0001
Nephropathy, yes	No	1.028	0.902 to 1.171	0.6815
CHF, yes	No	1.196	1.033 to 1.384	0.0168
CVD, yes	No	1.246	1.122 to 1.384	<0.0001
Tobacco, yes	No	0.906	0.725 to 1.132	0.3830
Diabetes mellitus, yes	No	1.234	1.120 to 1.368	<0.0001
Hypercholesterolemia, yes	No	1.207	1.092 to 1.334	0.0002

BP stage based on untreated BP levels for those not on medications and treated levels for those on medications.



**TABLE 4. Random Effect Multivariable Regression Models Relating the Therapeutic Inertia Score to Change in SBP and DBP From First to Last Visits and the Probability of Last Visit BP <140/90**

Variables	SBP Change		DBP Change		BP<140/90		
	Coefficient*	P Value	Coefficient	P Value	OR	95% CI	P Value
TI score (per 0.1 unit increment)	-3.139	<0.0001	-1.028	<0.0001	0.608	0.591 to 0.625	<0.0001
SBP index	0.848	<0.0001	...	...	0.993	0.989 to 0.997	0.0006
DBP index	...	...	0.746	<0.0001	1.002	0.994 to 1.009	0.6457
Race (black vs white)	-1.984	<0.0001	-0.213	0.2724	0.907	0.768 to 1.071	0.5653
Sex (male vs female)	-1.036	0.1135	0.250	0.2905	0.970	0.845 to 1.114	0.6701
Age	-0.135	<0.0001	0.171	<0.0001	0.994	0.988 to 1.000	0.0329
Diabetes mellitus	-1.322	0.0143	1.349	<0.0001	0.956	0.835 to 1.094	0.5125
Hypercholesterolemia	0.131	0.8028	0.549	0.0744	1.059	0.922 to 1.217	0.4190
Nephropathy	-0.814	0.2616	0.762	0.0463	0.999	0.844 to 1.184	0.9932
CVD	-0.492	0.4081	1.258	0.0008	1.023	0.863 to 1.213	0.7934
CHF	0.839	0.1811	0.406	0.2548	1.029	0.848 to 1.248	0.7719
Tobacco	-3.422	0.0040	-0.982	0.1505	0.785	0.626 to 0.985	0.0365

OR indicates odds ratio.

\*Coefficients denote the change in BP between first and last visits for a specified change in the independent variable. A negative coefficient denotes smaller declines in the BP with increasing value of the variable.

86.9% of visits when the BP was  $\geq 140/90$  mm Hg. Moreover, TI was an important determinant of subsequent BP change. Patients in the lowest quintile of TI score achieved  $8.6 \pm 1.6/3.7 \pm 1.0$  mm Hg greater reductions in BP by the last visit than patients in the top quintile. Uncontrolled hypertensive patients in the lowest quintile of TI score were  $>32$  times as likely to attain BP control to  $<140/90$  mm Hg at their final clinical visit in 2003 than patients in the highest quintile.

The adjusted effects of TI over the 1-year period on final BP were 13.8/4.5 mm Hg, assuming a linear relationship of TI to the change in BP. A decline of this magnitude would decrease the average last visit BP of the analyzed sample to 125.8/73.4 mm Hg and increase the proportion of controlled hypertensives at the last visit to a projected 77.6%, which is better than all of the clinical trials to date. A more realistic 20% improvement in the proportion of visits in which antihypertensive therapy is intensified, that is, a 50% reduction in TI score, translates to a BP at the last visit of 132.7/75.6 mm Hg and a projected hypertension control rate to  $<140/90$  mm Hg of 65.9%, which is virtually identical to that obtained in the Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack trial.<sup>4</sup> Extrapolation of results from analysis of only those visits with elevated BP showed that failure to intensify therapy resulted in a 7.8/2.7 mm Hg higher BP over 1 year.

These extrapolations may overestimate the impact of TI, because many patients would likely achieve the goal with a smaller reduction in BP and would not be candidates for additional intensification of treatment. The extrapolation is provided to emphasize the potentially large contribution of reducing the TI score by 50% (ie, increasing medication change rate from 11% to 30% of visits) in the efforts to improve BP control. These observations suggest that among hypertensive patients receiving regular care, modest reductions in TI could lower SBP by  $>5$  mm Hg, which has been shown to reduce cardiovascular and all-cause mortality by

7% to 14% or more,<sup>26,27</sup> with improved hypertension control rates to nearly two-thirds of patients.

This study shows that the rate of TI is high in all practice types. Whereas TI rates were not different at VA compared with non-VA sites, VA patients experienced approximately twice the decline in BP (5.7/3.5 versus 2.8/1.7 mm Hg;  $P<0.0001$ ) during the year. This observation may reflect differential access to medications with advantages for patients at VA sites.<sup>15,28</sup>

The explanation(s) for the high rates of TI could not be discerned from our database because of the absence of physician level variables and detailed information on the physician-patient encounter. This limitation in the database prompted us to use the term TI, given our focus on medication change rates, rather than clinical inertia, which implies a more comprehensive analysis of the management plan. Patient level variables associated with higher TI scores included stage 1 versus stage 2 BP readings, older age, fewer antihypertensive medications, and comorbidities, such as diabetes mellitus, nephropathy, CHF, and CVD. TI is high across demographic, geographic, and practice characteristics and has remained high over the last 10 to 15 years.<sup>16,19</sup> A Canadian study,<sup>29</sup> however, noted that physician management of hypertension in the elderly was more aggressive in 2002 compared with 1994. This was, however, not noted in the United States comparing studies done using 1990 to 1995 data<sup>16</sup> to that done using 1999 data<sup>19</sup> and to present study.

TI decreased with increasing BP and was clearly less for readings in the stage 2 compared with stage 1 hypertension range as noted in prior studies.<sup>16,19</sup> The majority of individuals with uncontrolled hypertension in this database were within 10/5 mm Hg of the goal BP. Prior reports have noted that the cardiovascular risk that accompanies the goal BP of 140/90 mm Hg is already double that of those with BP 120/80 mm Hg.<sup>3</sup> Reduction of TI in this group, therefore, has the potential not only to substantially improve overall BP

control rates but also to significantly reduce cardiovascular complications.

The explanation for the higher TI in patients with comorbid risk factors including diabetes mellitus and nephropathy is not clear but has been reported in prior studies.<sup>30,31</sup> One prior study suggested that the complexity of simultaneously managing multiple risk factors in diabetics did not explain higher rates of TI, because increases in antihypertensive medications were no less likely for those visits in which diabetic medications were also changed.<sup>30</sup> In contrast, other studies on the management of chronic medical conditions in patients with comorbidities have implicated competing demands<sup>32</sup> and burden of comorbid illness.<sup>33</sup> Lack of knowledge of medical guidelines, for example, the lower BP goal in patients with diabetes or nephropathy,<sup>34,35</sup> probably does not explain the differences in TI in this study between patients with diabetes mellitus or nephropathy and those without. For this report, uncontrolled hypertension was defined by a BP reading  $\geq 140/90$  mm Hg for all of the patients. The disparity with higher TI in patients with diabetes and nephropathy would have been even greater if the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure VI control goal of  $<130/85$  mm Hg, which was in effect during 2003, had been applied to these 2 groups.

Although TI was not significantly different between black and white hypertensive patients after adjusting for covariates, including severity of hypertension, hypertension control rates were higher in whites. This observation suggests that the ethnic disparity in BP control likely reflects other factors, for example, differences in lifestyle and environmental stressors, access to and/or adherence with medications, or more treatment-resistant hypertension rather than TI.<sup>13,36</sup> Nevertheless, reducing TI in all of the hypertensive patients, irrespective of ethnicity, would likely improve BP control.

The limitations of this study include the fact that the database did not include variables that could explain failure to adjust medications, for example, the patient refused to take more medication or the patient received education on adherence and lifestyle change. Even if we assume that advice on lifestyle modification was given to all of the patients with TI, the fact that their BP did not improve over 1 year suggests that the effects on the change in BP readings and control to  $<140/90$  mm Hg are likely less than the effects of intensifying antihypertensive therapy. Second, the database did not include physician level factors, such as age, race, and year of graduation, which may influence TI. The comparatively low intraclass correlation coefficient of 0.04 for the TI score raises the intriguing possibility that TI may not be determined predominantly by physician characteristics. The TI scores for subjects seeing the same physician were only slightly more similar than for those seeing different physicians. Third, data were entered into different electronic medical records or recorded on data cards by various providers and staff at participating clinics. Fourth, BP measurements were not standardized across clinics. Fifth, only 1 BP reading was entered into the database on a single visit for each patient. It is possible that an initial higher BP reading was recorded in the database but that a subsequent lower reading that influenced the decision to maintain therapy was not recorded. Sixth, the methods and

credentials of the individuals obtaining the BP readings are not known. Last, office hypertension, which is a valid reason for not adjusting antihypertensive medications in some patients, was not identified.

Despite these limitations, the database is a comparatively accurate reflection of contemporary primary health care for hypertensive patients in the community. The database contains information on a broad spectrum of patients from diverse healthcare systems. Moreover, the findings are consistent with previous reports that the prevalence of uncontrolled hypertension is substantially higher in clinical practice than in clinical trials and that the rate of therapeutic intensification for uncontrolled BP is low.

### Perspectives

This study confirms the high rate of TI in the management of hypertension and extends previous reports by quantifying the impact of TI on BP control. Our data suggest that an absolute improvement of 20% in the percentage of visits accompanied by intensification of therapy could improve control rates from 46.2% to 65.9% among patients receiving regular or continuous care as defined in this report. Reducing TI could represent a major contribution to controlling BP in two-thirds of treated hypertensive patients and 50% of all hypertensive patients, which is the Healthy People 2010 goal. In the absence of large improvements in the prevalence of patients with diagnosed and treated hypertension and given current pharmacological tools and treatment strategies, substantial progress toward the Healthy People 2010 BP goal will require a significant decline in TI. Interventions to reduce TI have the potential to significantly improve hypertension control rates and reap more of the evidence-based benefits in reducing cardiovascular and renal morbidity and mortality.

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