Predictors of blood pressure control in an urban primary care setting

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Despite evidence of decreased cardiovascular disease morbidity and mortality, control of blood pressure is largely suboptimal especially in urban settings. Evaluation of predictors of blood pressure control in these settings is exceedingly important in order to develop strategies for improved outcomes. **Methods:** We surveyed 259 African–American patients with essential hypertension in an urban primary care setting. Patients were divided into two groups, based on whether blood pressure was controlled, below 140/90 mmHg (n = 181; 70%) or uncontrolled, above 140/90 mmHg (n = 78; 30%). Predictors of blood pressure control were determined using multivariable logistic regression. **Results:** There were no differences between the two groups in mean age, body mass index or gender. Controlled as compared with uncontrolled patients had a significantly higher percentage of reporting regular exercise (p = 0.01), lower rate of blood pressure medication nonadherence (p = 0.03), were less likely to be prescribed calcium channel blockers (p = 0.01), lower rate of total serum cholesterol (<240 mg/dl; p = 0.03) and lower serum creatinine (p = 0.04). All other factors were similar between the two groups. The odds ratio (OR) of uncontrolled blood pressure was associated with lack of regular exercise (OR: 2.26; 95% confidence interval [CI]: 1.16–4.37; p = 0.02), use of calcium channel blockers (OR 2.30; 95% CI: 1.22–4.32; p = 0.01), total cholesterol greater than 240 mg/dl (OR: 3.10; 95% CI: 1.36–7.00; p = 0.01), and blood pressure medication nonadherence (OR: 1.96; 95% CI: 1.02–3.74; p = 0.01). **Conclusion:** These data form a basis, and indicate the need for focused interventions to control blood pressure in urban primary care settings.

Keywords: African–American, exercise, hypertension, nonadherence

Background:

Hypertension affects 58 million people in the USA [1] with nearly 35 million office visits per year as the primary method of diagnosis [2]. Worldwide prevalence of hypertension is as high as 1 billion [3], with approximately 7.1 million deaths each year attributed to hypertension. Hypertension increases with advancing age so that more than half of people aged 60 to 69 years and approximately three-quarters of those aged 70 years and older are affected [4].

According to the Joint National Committee (JNC) 7 [2], the relationship of hypertension to cardiovascular disease (CVD) is continuous, consistent and independent of other risk factors. Patients with a systolic blood pressure (SBP) between 120 and 139 mmHg are considered prehypertensive and require lifestyle modifications to prevent CVD. Starting at 115/75 mmHg, CVD risk doubles with each increment of 20/10 mmHg blood pressure (BP). The World Health Organization (WHO) reports that suboptimal BP (>115 mmHg SBP) is responsible for 62% of cerebrovascular disease and 49% of ischemic heart disease, with little variation by gender. In addition, suboptimal BP is the most attributable risk of death throughout the world [101].

Although hypertension awareness, diagnosis and therapy is widespread, according to the National Health and Nutrition Examination Survey (NHANES) III data, only 27% of Americans with hypertension have their BP controlled below 140/90 mmHg. Hypertension is more prevalent in African–Americans than Caucasians and, despite comparable treatment, data now suggest that African–Americans are less likely than Caucasians to have BP controlled to less than 140/90 mmHg [5]. A detailed analysis of the predictors of BP control is therefore needed in African–American patients. In this study, we examined various modifiable factors that that can potentially predict control of BP in African–American patients in an urban primary care setting.

Methods

The study was approved by Institutional Review Board of State University of New York (SUNY) Downstate Medical Center, Brooklyn, NY. A total of 302 hypertensive patients attending general medical clinics in an urban academic medical center were approached over a two month period, of which 259 met the inclusion criteria

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and agreed to participate in the survey. Inclusion criteria were:

- African–American
- Essential hypertension
- Diagnosis of hypertension for more than 1 year
- Medical clinic attendance for more than 1 year
- Willingness to participate in the survey

Exclusion criteria were:

- NonAfrican–American
- Diagnosis of secondary hypertension
- Less than 1 year participation in the clinic
- Unwilling to participate

Screening was performed during the clinical encounter with the physician and eligible patients were directed to the research assistants after the visit to complete the survey.

Patients were divided into two groups, based on whether BP was controlled (n = 181; 70%) or uncontrolled (n = 78; 30%). Patients were interviewed face to face and the information confirmed from existing medical records by three research assistants who were trained to conduct the interviews and understand the definitions of all variables. Information that was recorded but could not be confirmed from medical records included:

- Nonadherence to BP medications
- Use of any form of over-the-counter medications or herbal remedies
- Use of nonsteroidal anti-inflammatory drugs and exercise
- Compliance with diet and current employment.

All other information confirmed from electronic or chart records included:

- Demographics and insurance data
- Other comorbid conditions
- Family history of hypertension
- Antihypertensive medications use
- Recent hospitalizations
- Diet
- Exercise
- Smoking and alcohol history
- Education
- Employment history
- Compliance with clinic appointments and/or nonadherence to BP medications

Laboratory data obtained from electronic records included:

- Serum hemoglobin
- Creatinine
- Blood urea
- Hemoglobin A1c and lipid profile

Definitions

Regular exercise was defined as brisk walking or similar activity at least three-times weekly. Smoking was defined as the use of cigarette within the past 6 months and alcohol abuse was defined as habitual daily alcohol intake. Nonadherence to BP medications was defined as missing or failing to take BP medications at least once a week. Recreational drug use was defined as any use of marijuana, cocaine or heroin at any time during the year. Over-the-counter medication was defined as use of any form of over-the-counter medications such as vitamins, pain killers or cold remedies. Over-the-counter cold remedies was defined as medication that included nasal or oral decongestant used for common colds. Use of herbal remedys was defined as use of alternative medicines or supplements.

Statistical analysis

The population was divided into two groups depending on whether BP was controlled over a 12-month period; (mean arterial pressure ≤107 mmHg or ≤140/90 mmHg; n = 181) or uncontrolled (mean arterial pressure >107 mmHg or >140/90 mmHg; n = 78). Differences between the two groups were determined using t-test for continuous variables (mean ± standard deviation [SD]) and Chi square (%) or Fisher's exact test (%) for categorical variables. Multivariable logistic regression analysis was performed to determine predictors of uncontrolled BP. The model for regression analysis was derived from significant variables ($p < 0.05$) in univariate analysis. Interactions between these significant variables were tested in this model. Serum cholesterol was entered as a categorical variable in this model using the cut-off point for drug therapy (≥240 mg/dl) so that conclusions could be derived for cholesterol control. These variables were entered in a stepwise fashion and the results reported as odds ratios (OR) and confidence intervals (CI). A two-tailed p-value of less than 0.05 was considered significant. All analysis was performed using SPSS version 10.0.

Table 1. Demographics and baseline characteristics of patients.

	Controlled (n = 181)	Uncontrolled (n = 78)	p-value
Mean age (years)	62 ± 13	63 ± 10	0.55
Mean body mass index	31 ± 7	31 ± 7	0.74
Categories of body mass index			0.22
≤25	17	13	
25–30	30	41	
>30	53	46	
Male gender (%)	31	31	0.98
Family history of hypertension (%)	71	73	0.77
Comorbid conditions (%)			
Diabetes	45	45	0.97
Angina	16	14	0.71
Heart failure	7	4	0.30
Stroke	8	7	0.60
Total cholesterol >240 mg/dl	12	23	0.03
Serum creatinine >1.5 mg/dl	12	12	0.96
Cigarette smoking	8	8	0.99
Excessive alcohol use	4	3	0.60
Other comorbidities	19	20	0.99
Hypertension therapy (%)			
Diuretics	59	69	0.24
Calcium channel blockers	42	60	0.01
ACEI/ARB	59	56	0.21
β-blockers	33	36	0.63
α-blockers	8	7	0.72
Mean number of BP medications	2.1 ± 1.3	2.3 ± 1	0.24
nonadherence to BP medications (%)	30	44	0.03
Recreational drug use (%)	1	1	0.53
Over the counter medications (%)	12	17	0.33
Over the counter cold remedies (%)	3	4	0.83
Use of herbal remedies (%)	7	10	0.32
Use of NSAIDS (%)	33	41	0.19
Follows salt restricted diet (%)	93	97	0.14
Regular exercise (%)	46	28	0.01
Missed clinics 1–2/year (%)	31	42	0.10
Missed clinics >2/year (%)	5	4	0.70
Currently employed (%)	28	23	0.43
Has some form of medical insurance (%)	73	62	0.10
Private insurance	24	21	0.56
Medicaid	42	37	0.47
Medicare	24	20	0.60
Hospitalizations in past year (%)	43	31	0.10
Reason for hospitalization (%)			0.70
Uncontrolled BP	7	9	

ACEI: Angiotensin converting enzyme inhibitors; ARB: Angiotensin receptor blockers; BP: Blood pressure; NSAID: Nonsteroidal anti-inflammatory drugs.

Table 1. Demographics and baseline characteristics of patients.

	Controlled (n = 181)	Uncontrolled (n = 78)	p-value
Cardiovascular disorders	29	22	
Kidney disease	3	9	
Other	61	60	

ACEI: Angiotensin converting enzyme inhibitors; ARB: Angiotensin receptor blockers; BP: Blood pressure; NSAID: Nonsteroidal anti-inflammatory drugs.

Results

The demographics and baseline clinical characteristics of the patients are summarized in Table 1. A total of 259 African–American patients with essential hypertension and a mean age of 62 ± 12 years were studied. Men accounted for 31% of the patients. A total of 70% of the population (n = 181) had achieved a 12-month mean average BP of less than 140/90 mmHg and were classified as controlled, whereas 30% (n = 78) had not achieved this target and were classified as uncontrolled. As shown in Table 1, controlled patients were not significantly different from uncontrolled as regards to mean age (62 ± 13 vs. 63 ± 10), body mass index (31 ± 7 vs. 31 ± 7), and male gender (31 vs. 31%). There were also no differences in family history of hypertension. Comorbid conditions were similar except the prevalence of total cholesterol greater than 240 mg/dl which was significantly lower in controlled over uncontrolled patients (12 vs. 23%; p = 0.03). Choice of antihypertensive medications was also similar between the two groups, except controlled patients were less likely to be prescribed calcium channel blockers than uncontrolled patients (42 vs. 60%; p = 0.01). Nonadherence to BP medication was significantly less prevalent in controlled than uncontrolled patients (30 vs. 44%; p = 0.03). Controlled patients were also significantly more likely to be engaged in regular exercise than uncontrolled patients (46 vs. 28%; p = 0.01).

There were no differences in mean number of BP medications, recreational drug use, any form of over-the-counter medications, use of nonsteroidal anti-inflammatory drugs, herbal remedies, diet, compliance with clinic visits, employment status, insurance coverage, hospitalizations and reasons for hospitalizations. As shown in Table 2, the 12-month average serum hemoglobin, blood urea nitrogen, hemoglobin A1c (for diabetics), triglycerides and high- and low-density lipoproteins results for the two groups were similar. However, controlled patients had significantly lower mean serum creatinine (1.1 ± 0.6 vs. 1.3 ± 0.9; p = 0.03) and total cholesterol (195.7 ± 44.0 vs. 210 ± 63.8; p = 0.03) as compared with uncontrolled patients.

Using multivariable logistic regression analysis (Table 3), the odds of uncontrolled BP was associated with lack of regular exercise (OR: 2.26; 95% CI: 1.16–4.37; p = 0.02), use of calcium channel blockers (OR: 2.30; 95% CI: 1.22–4.32; p = 0.01), total cholesterol of over 240 mg/dl (OR: 3.10; 95% CI: 1.36–7.00; p = 0.01), and BP medication nonadherence (OR: 1.96; 95% CI: 1.02–3.74; p = 0.01). There were no interactions between these variables. For every 0.4 mg/dl rise in serum creatinine above 1 mg/dl, there was an

Table 2. Analysis of 12-month mean laboratory values (mean ± SD) between the two groups.

	Controlled	Uncontrolled	p-value
Mean hemoglobin (g/dl)	12.7 ± 1.4	12.9 ± 1.4	0.11
Mean blood urea nitrogen (mg/dl)	17.5 ± 8.0	19.0 ± 10	0.20
Mean serum creatinine (mg/dl)	1.1 ± 0.6	1.3 ± 0.9	0.04
Hemoglobin A1c (%)	8.3 ± 1.9	8.6 ± 2.3	0.37
Mean total cholesterol (mg/dl)	195.7 ± 44.0	210.0 ± 45.0	0.03
Mean triglyceride (mg/dl)	126.0 ± 68.5	133.0 ± 63.8	0.54
Mean HDL (mg/dl)	58.3 ± 16	62.3 ± 26.5	0.18
Mean LDL (mg/dl)	114.4 ± 39.3	122 ± 38.2	0.16

HDL: High-density lipoprotein; LDL: Low-density lipoprotein; SD: Standard deviation.

Table 3. Multivariable logistic regression analysis for predictors of BP control.

	Odds Ratio	95% CI	p-value
Lack of regular exercise (vs. regular)	2.26	1.1 6–4.37	0.02
Use of calcium channel blockers (vs. no use)	2.30	1.2 2–4.32	0.01
Total cholesterol >240 mg/dl (vs. <240 mg/dl)	3.10	1.3 6–7.00	0.01
Medication nonadherence (vs. none)	1.96	1.0 2–3.74	0.04
Serum creatinine rise 0.4 mg/dl	1.50	0.9 8–2.31	0.06

BP: Blood pressure; CI: Confidence interval.

increased risk of being uncontrolled but this did not achieve statistical significance (OR: 1.50; 95% CI: 0.98–2.31; p = 0.06).

Discussion

In this African–American population with essential hypertension treated in an urban clinic setting, we demonstrated that lack of regular exercise, uncontrolled hypercholesterolemia, medication nonadherence and being prescribed calcium channel blockers all independently predicted uncontrolled BP. The association of calcium channel blockers with uncontrolled BP may be due to higher physician prescribing practices of calcium channel blockers in patients with uncontrolled hypertension. Diuretics and blockers of the renin–angiotensin system were the most commonly prescribed antihypertensive medications consistent with current standards [6–10].

Our findings are consistent with prior observations that nonadherence to medications [11–13] and lack of regular exercise [14,15] adversely affect BP control. In contrast to Bone and colleagues we did not find any impact of age and employment status [14]. Our findings are intriguing since lack of regular exercise and medication nonadherence are potentially modifiable risk factors. An average reduction in BP by up to 4 to 9 mmHg may be achieved by regular exercise alone [16]. Gregg and colleagues showed that the cardiovascular benefits of slow walking appeared to be comparable to those of walking more quickly and there was an overall reduction in cadiovascular outcomes by approximately 50% [17]. Increased physical activity, when combined with a reduction in calories, is thus essential to success in weight loss. Based on the available evidence, engaging in regular physical activity for at least 60 to 90 min/week of walking can reduce CVD mortality by about 50% [18]. An exercise program is not only indicated for control of BP but also control of overall CVD risk in this population.

Adherence to the medical treatment prescribed is one of the most important factors necessary for control of BP. In one study by Baune and colleagues, significant associations were found between occurrence of stroke and noncompliance with medications (OR: 6.07; 95% CI: 1.53–24.07) and regular physical exercise was found to be protective (OR: 0.26; 95% CI: 0.12–0.57) [19]. Gascon and colleagues showed that fears and negative images of antihypertensive drugs and a lack of basic background knowledge about hypertension were associated with noncompliance [20]. Similarly, Andrade and colleagues found the major reasons alleged for not adhering to treatment were [21]:

- Normalization of BP
- Side effects of the medications
- Forgetting to use the medication
- Cost of medication
- Fear of mixing alcohol and medication
- Ignoring the need for continuing the treatment
- Use of an alternative treatment
- Fear of intoxication
- Fear of hypotension
- Fear of mixing the medication with other drugs

Physician-related factors may also contribute to uncontrolled BP. Hyman and colleagues found that physician inaction toward elevated SBP due to a reluctance to prescribe multiple drugs and/or lack of belief in the benefits of aggressive treatment to lower SBP below 140 mmHg, was considered to have an impact on BP [22]. Physicians should therefore communicate instructions clearly and prescribe therapies that are effective, affordable and have minimal or no adverse effects on patient quality of life or overall cardiac risk profile.

Our study is limited due to possible bias in the selection of patients to participate in the interviews. The duration of the study could

have also excluded patients who may have otherwise participated. We did not obtain information on income to ascertain ability to pay for medications. The clinic where the study was conducted provides medications to all its patients, therefore ability to afford medications was not formally addressed here. It is interesting to note that most of the patients had some form of insurance, which makes it likely for them to be able to afford medications. Reliability of answers provided for exercise and nonadherence is also a limitation, since these variables could not be confirmed. The surveyors explained these variables and obtained the best information possible.

Expert commentary

We conclude that our data identify specific risk factors for uncontrolled hypertension. This should form a basis for comprehensive health education programs in order to educate patients on the benefits of exercise, weight reduction, healthy dietary habits; compliance with medications and clinic visits, and thus decrease overall CVD morbidity.

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