Published in final edited form as:

J Clin Nurs. 2012 May ; 21(9-10): 1401–1406. doi:10.1111/j.1365-2702.2011.03859.x.

Baseline Medication Adherence and Blood Pressure in a 24-month Longitudinal Hypertension Study

Ryan Shaw, MS, RN¹ and Hayden B. Bosworth, PhD^{1,2,3}

¹Duke University School of Nursing, Durham, NC, USA

²Center for Health Services Research in Primary Care, Durham VAMC, Durham NC, USA

³Department of Medicine, Division of General Internal Medicine, Department of Psychiatry and Behavioral Sciences, Duke University, Durham NC, USA

Abstract

Aim and objectives—We sought to identify the feasibility and predictive validity of an easy and quick self-reported measure of medication adherence and to identify characteristics of people with hypertension that may warrant increase attentiveness by nurses to address hypertensive self-management needs.

Background—Current control rates of hypertension are approximately 50%. Effective BP control can be achieved in most people with hypertension through antihypertensive medication. However, hypertension control can only be achieved if the patient is adherent with their medication regimen. Patients who are non-adherent may be in need of additional intervention.

Design—This secondary analysis evaluated the systolic blood pressure (SBP) of patients who received usual hypertension management across 24 months at 6-month intervals.

Methods—A longitudinal study of 159 hypertensive patients in two primary care clinics.

Results—In a sample of 159 patients receiving care in a primary care facility, baseline medication non-adherence was associated with a 6.3 mmHg increase in SBP ($p < 0.05$) at baseline, a 8.4 mmHg increase in SBP ($p < 0.05$) at 12 months and a 7.5 increase in SBP at 24 months ($p < 0.05$) compared with adherent patients, respectively. Results also indicate a significant increase in SBP across 24 months among people who identified as minority and of low financial status.

Conclusions—Non-adherence with antihypertensive medication at baseline was predictive of increased SBP up to 24 months post-baseline.

Relevance to clinical practice—This study demonstrates the use of an easy-to-use questionnaire to identify patients who are non-adherent. We recommend assessing medication adherence to identify patients who are non-adherent with their anti-hypertensive medication and to be especially vigilant with patients who are minority or are considered low income.

Correspondence to: Ryan Shaw, PhD Candidate, Duke University School of Nursing, DUMC 3322 307 Trent Drive, 3080. Durham, NC, 27710. Direct: (919) 684-9198, Fax: (919) 681-8899, ryan.shaw@duke.edu.

The views expressed in this manuscript are those of the authors and do not necessarily represent the views of the US Department of Veterans Affairs.

Study Design: HB

Data Collection and Analysis: RS, HB

Manuscript Preparation: RS

Conflict of interest: No authors have a conflict of interest

Keywords

Blood pressure; medication adherence; nursing; nurses; longitudinal

INTRODUCTION

Over 74.5 million Americans, one in three adults, are affected by hypertension, defined as blood pressure (BP) $\geq 140/90$ mmHg or taking an antihypertensive medication for non-diabetics and $\geq 130/80$ mmHg for individuals with diabetes (American Heart Association 2010). Hypertension is the most common primary diagnosis in America (Cherry & Woodwell 2000) and current control rates are only at 50% (Egan *et al.* 2010).

BACKGROUND

Hypertension is a significant risk factor for cardiovascular disease (CVD). The relationship between BP and risk of CVD is continuous and independent of other risk factors. Even among normotensive individuals at age 55, there is a 90 percent lifetime risk of developing hypertension (National Heart Lung and Blood Institute 2003).

Effective BP control can be achieved in most people with hypertension through lifestyle modification and antihypertensive drugs. Most people with hypertension require two or more hypertensive medications to achieve BP control (Cushman *et al.* 2002, Black *et al.* 2001). Recent studies suggest that nurse-administered self-management interventions can have positive economic impact and improve BP control, systolic BP and diastolic BP across 24 months compared with usual care (Bosworth *et al.* 2009, Reed *et al.* 2010).

However, even among the most diligent clinicians, hypertension control can only be achieved if the patient is adherent with their medication regimen. Patients who are non-adherent with their medication regimen may be in need of additional intervention. Poor adherence to BP drug therapy can translate into a greater risk of BP related complications and increased health care expenditures (Flack *et al.* 1996).

Nurses are in a crucial position to identify patients who are non-adherent with their antihypertensive medication regimen and to target patients who may be in need of additional intervention to improve BP self-management. Identifying and addressing self-management interventions is a key role in nursing (Wagner, 2000) and a major part of the national nursing agenda (National Institute of Health, 2006).

We sought to identify the feasibility and predictive validity of an easy and quick self-reported measure of medication adherence and to identify characteristics of people with hypertension that may warrant increase attentiveness by nurses to address hypertensive self-management needs.

Methods

This study is an analysis of the randomised usual care group (n=156) from the Take Care of Your Blood Pressure (TCYB) trial. Recruitment occurred from May 2004 - December 2005, with follow-up from November 2004 to January 2008. Details on the study design and the interventions have been reported previously (Bosworth *et al.* 2009, Bosworth *et al.*, 2008).

BP was measured at baseline and at six-month intervals for 24 months. Patients received standard hypertension care from their primary care provider and underwent 6-month

outcome assessment measurements. Institutional Review Board approval was obtained from the Duke University Health System and all patients provided written informed consent.

Outcomes and Measurements

Demographics were obtained from patients and medical chart review at baseline (Table 1). Financial status was evaluated by asking patients to report whether they had enough money to pay bills only by cutting back on things or if they had difficulty paying bills (Bosworth, *et al.*, 2001). Health literacy was evaluated as a dichotomous variable defined as $\leq 8^{\text{th}}$ (≤ 60) versus $> 9^{\text{th}}$ (> 61) on the REALM (Dewalt, *et al.*, 2004). Body mass index was calculated from a mean between self-reported weight and body weight abstracted from the medical record.

Blood pressure was measured at six-month time points over 24 months. At each time point, a research assistant who was blinded to the patient's group assignment obtained 2 BP measurements with a digital sphygmomanometer. The first BP measurement was obtained after patients were seated and rested for at least 5 minutes. The second was obtained 30 seconds after the first. The mean of the values was used as the outcome for that time point. We chose to examine systolic BP (SBP) for this study because SBP greater than 140 mmHg is a more important risk factor than diastolic blood pressure for the majority of people with hypertension (Izzo *et al.*, 2000).

Medication non-adherence was assessed at baseline and months 6 and 24 using a five-item measure based on the Morisky scale ($\alpha = 0.86$). Response options ranged from strongly agree (1) to strongly disagree (4) and also included options for 'don't know' and 'refused.' The questions asked included the following: I sometimes forget to take my blood pressure medicine; I am sometimes careless about taking my blood pressure medicine; when I feel better, I sometimes stop taking my blood pressure medicine; if I feel worse when I take the blood pressure medicine, sometimes I stop taking it and; I have skipped doses in the past month. Consistent with prior research (Thorpe *et al.* 2009), a summary binary variable was created by coding those who responded 'strongly agree,' 'agree,' 'don't know,' 'refused,' or missing data to any of the 5 questions as 1 (non-adherent). This indicated a patient was not fully compliant with their medication regimen; otherwise patients received a value of 0 (adherent). The time frame of responding to medication adherence was the last month.

Statistical Analysis

A correlation analysis (PROC CORR in SAS, version 9.2) was used to estimate which demographic variables were significantly correlated with blood pressure in the usual care group. A repeated linear regression model (PROC REG in SAS, version 9.2) was used to estimate the predictive validity of baseline medication adherence over 24 months. A general linear model (PROC MIXED in SAS, version 9.2) (Singer & Willet 2003) was used to estimate change in BP over 24 months between adherent and non-adherent medication users at baseline. The fixed effects for the model included a common intercept, the stratification variables included adherence and time (in months) and the following interaction term: adherence by month. The same subjects were used for each analysis.

Results

Of the 159 patients, 54% were African American, 64% were female and 20% reported inadequate income. The mean age was 62 years old (Table 1). At baseline, mean systolic BP was 124 mmHg; 72% had their BP under control at baseline and 32% reported that they were non-adherent with their medication. Overall BP measurements were available for 128

(81%) of patients at 24 months of follow-up (Baseline 157; 6 months 144; 12 months 131; 18 months 129; 24 months 128).

There was no significant change in SBP between ($P = 0.80$) over 24 months in the sample. Non-adherence at baseline was predictive of the following: a 6.3 mmHg increase in SBP ($P < 0.05$) at baseline; a 8.4 mmHg increase in SBP ($p < 0.05$) at 12 months; and a 7.5 increase in SBP at 24 months (Fig. 1) ($P < 0.05$).

A correlation analysis indicated that financial status and race were significantly ($p < 0.05$) correlated with SBP and medication adherence. There was no significant difference in SBP by gender ($p > 0.05$). Thus, we added these potential confounders to the model. Low financial status was indicative of a 3.2 mmHg increase in SBP at baseline ($p = 0.04$). Race (minority status) was indicative of a 10.6 mmHg increase in SBP at baseline ($p < 0.01$), a 7.4 mmHg increase in SBP at 12 months ($p < 0.05$) and a 7.9 mmHg increase in SBP at 24 months ($p < 0.05$). When these variables were added to the model both adherence and financial status were no longer significant indicators of increased SBP ($p > 0.05$). However, minority status continued to indicate an 8.9 mmHg increase in SBP when all three variables were added to the model ($p > 0.01$) (Fig. 2).

Discussion

The purpose of this study was to understand if medication adherence is a significant predictor of SBP over time and to identify characteristics of people with hypertension that may warrant increase attentiveness by nurses to address hypertensive self-management needs. As demonstrated by this study and consistent with the literature (Munger *et al.* 2007, Perreault *et al.* 2010), non-adherence is related to elevated BP (+6.3 mmHg at baseline). In this study non-adherence continued to demonstrate elevated SBP over 24 months compared with patients who were adherent. Financial status was also an indicator of elevated SBP (+3.2 mmHg). Thus, financial status may be an additional factor to consider when targeting patients for hypertension management. Though adherence and financial status were significant predictors of elevated SBP, results from this study indicate that minority status was an even greater factor in elevated BP (+10.6 mmHg) at baseline. This is consistent with literature that shows that hypertension is greater among blacks than other races (Ong, *et al.* 2007). Race was such a significant factor that when it was added to the statistical model it accounted for the effect of medication adherence and financial status. In addition, results indicated that SBP did not vary over a two-year period in the sample studied even though at baseline 28% of patients had uncontrolled BP.

The modified five-item Morisky scale was reliable ($\alpha = 0.86$) and demonstrated predictive validity of up to 24-months post-baseline. This is consistent with the literature that the Morisky scale has been shown to be reliable ($\alpha = 0.83$) (Morisky, Green & Levine 1986), significantly associated with blood pressure control and has good concurrent and predictive validity in primarily low income, minority patients with hypertension (Morisky *et al.* 2008). Other self-reported medication adherence measures have been used in research settings as well (Morisky *et al.* 1986, Kim *et al.* 2000, Shea *et al.* 1992). Consistent demonstration of validity and reliability in diverse populations is continually needed.

Medication adherence in relationship to BP and cardiovascular events has been well studied. Non-adherence has been documented to occur in over 60% of cardiovascular patients (Kravitz *et al.* 1993) leading to poor clinical outcomes, including rehospitalisation, subsequent myocardial infarction and increased mortality in various patient settings (Baroletti & Dell'Orfano 2010). Due to the relationship between antihypertensive medication non-adherence and elevated BP, non-adherence provides an opportunity to

significantly improve BP management. In particular, clinicians need to be diligent and sensitive to the needs of individual needs of patients to promote optimal medication adherence. By identifying patients who are non-adherent to their antihypertensive medication regimen at baseline through a quick and easy questionnaire such as the short Morisky (Morisky *et al.* 1986) used in this study, clinicians can quickly and easily identify patients who are in need of additional intervention and follow-up. Assessing medication adherence may be particularly useful in certain minority groups. Minorities in particular have been shown to have higher rates of hypertension than others racial groups (Ong, *et al.* 2007). As seen in Fig. 2, the elevated SBP was greatest in people who identified as both minority and were non-adherent with their antihypertensive medications.

Results that SBP in this study did not change over a 24-month period reflect that many patients with hypertension do not receive proper treatment. Over 75% of patients who receive hypertension treatment worldwide fail to reach normotension (BP < 140/90). This is a significant problem and warrants increased vigilance by physicians and nurses to appropriately adjust therapy and deliver proper management. This study was limited by being a secondary analysis of a larger trial where the purpose was to evaluate the effects of a home BP monitoring self-management intervention and nurse-administered behavioral intervention compared with usual care. Medication adherence was not the focus of the primary study.

Relevance to Clinical Practice

To surpass the Healthy People 2020 goal of reducing the proportion of adults with hypertension, multiple strategies are needed. The national guideline clearinghouse (NGC) advocates nurses as one approach towards hypertension management (Heart and Stroke Foundation of Ontario & Registered Nurses Association of Ontario 2005). NGC recommends that nurses assess and promote the adherence of patients' anti-hypertension treatment plan. The benefits of nurses delivering behavioral interventions and hypertension management to patients have been demonstrated (Bosworth *et al.* 2009, Reed *et al.* 2010). Based on the results from this study that demonstrate the predictive validity of a baseline medication adherence tool up to 24 months and a significant increase in SBP among non-adherent patients, we recommend nurses and other clinicians assess medication adherence to identify patients who are non-adherent with their hypertension medication. An easy-to-use questionnaire such as the Morisky is one tool that can be used to reliably gauge and predict medication adherence. By identifying non-adherent patients at baseline, additional behavioral interventions can be delivered which focus on promoting medication adherence which can in turn potentially further improve blood pressure among hypertensive patients. In addition, increase vigilance is needed to target communities and groups that are known to have increased rates of hypertension, including minorities and those of lower income status. With approximately 65% of men and 80% of women who reach the age of 75 developing hypertension (National Center for Health Statistics 2008), strategies to reduce the prevalence of hypertension in the general public are greatly needed. Nurses are in a pivotal role to help manage and reduce the prevalence and burden of hypertension.

Acknowledgments

This research is supported by a NHLBI grant R01 HL070713 and registered at ClinicalTrials.gov, a Pfizer Foundation Health Communication Initiative award, Established Investigator Award from the American Heart Association, and from Veterans Affairs, Health Services Research and Development, a career scientist award (RCS 08-027) to the second author.

References

- American Heart Association. High Blood Pressure Statistics. 2006 <http://www.americanheart.org/presenter.jhtml?identifier=4621>.
- Baroletti S, Dell'Orfano H. Medication adherence in cardiovascular disease. *Circulation*. 2010; 121(12):1455–1458. [PubMed: 20351303]
- Black HR, Elliott WJ, Neaton JD, Grandits G, Grambsch P, Grimm RH, Hansson L, Lacouciere Y, Muller J, Sleight P, Weber MA, White WB, Williams G, Wittes J, Zanchetti A, Daniel Fakouhi T, Anders RJ. Baseline Characteristics and Early Blood Pressure Control in the CONVINCE Trial. *Hypertension*. 2001 Jan; 37(1):12–18. 2001. [PubMed: 11208750]
- Bosworth HB, Bastian LA, Kuchibhatla MN, Steffens DC, McBride CM, Skinner CS, Rimer BK, Siegler IC. Depressive symptoms, menopausal status and climacteric symptoms in women at midlife. *Psychosomatic Medicine*. 2001; 63:603–608. [PubMed: 11485114]
- Bosworth HB, Olsen MK, Grubber JM, Neary AM, Orr MM, Powers BJ, Adams MB, Svetkey LP, Reed SD, Li Y, Dolor RJ, Oddone EZ. Two self-management interventions to improve hypertension control: a randomized trial. *Annals of Internal Medicine*. 2009; 151(10):687–695. [PubMed: 19920269]
- Bosworth HB, Olsen MK, Neary A, Orr M, Grubber J, Svetkey L, Adams M, Oddone EZ. Take Control of Your Blood Pressure (TCYB) study: a multifactorial tailored behavioral and educational intervention for achieving blood pressure control. *Patient Education and Counseling*. 2008; 70(3): 338–347. [PubMed: 18164894]
- Cherry DK, Woodwell DA. National Ambulatory Medical Care Survey: 2000. *Advance Data from Vital and Health Statistics*. 2002:328.
- Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, Jones DW, Materson BJ, Oparil S, Wright JT, Roccella EJ. National Heart Lung and Blood Institute., National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure, National High Blood Pressure Education Program Coordinating Committee. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure. 2003; 289(19):2560–2572. 21.
- Cushman WC, Ford CE, Cutler JA, Margolis KL, Davis BR, Grimm RH, Black HR, Hamilton BP, Holland J, Nwachuku C, Papademetriou V, Probstfield J, Wright JT, Alderman MH, Weiss RJ, Piller L, Bettencourt J, Walsh SM. ALLHAT Collaborative Research Group. Success and predictors of blood pressure control in diverse North American settings: the antihypertensive and lipid-lowering treatment to prevent heart attack trial (ALLHAT). *Journal of Clinical Hypertension*. 2002; 4(6):393–404. [PubMed: 12461301]
- Dewalt DA, Berkman ND, Sheridan S, Lohr KN, Pignone MP. Literacy and health outcomes: A systematic review of the literature. *Journal of General Internal Medicine*. 2004; 19:1228–1239. [PubMed: 15610334]
- Egan BM, Zhao Y, Axon RN. US trends in prevalence, awareness, treatment and control of hypertension, 1988–2008. *Journal of the American Medical Association*. 2010; 303(20):2043–2050. [PubMed: 20501926]
- Flack JM, Novikov SV, Ferrario CM. Benefits of adherence to anti-hypertensive drug therapy. *European Heart Journal*. 1996; 17 Suppl A:16–20. [PubMed: 8737196]
- Heart and Stroke Foundation of Ontario, Registered Nurses Association of Ontario. [Retrieved November 13, 2010] Nursing management of hypertension. 2005. from <http://www.guideline.gov/content.aspx?id=15610&search=Hypertensive+disorder>
- Izzo JL, Levy D, Black HR. Clinical Advisory Statement. Importance of systolic blood pressure in older Americans. *Hypertension*. 2000; 35:1021–1024. [PubMed: 10818056]
- Kim MT, Hill MN, Bone LR, Levine DM. Development and testing of the Hill-Bone Compliance to High Blood Pressure Therapy Scale. *Progress in Cardiovascular Nursing*. 2000; 15(3):90–96. [PubMed: 10951950]
- Kravitz RL, Hays RD, Sherbourne CD, DiMatteo MR, Rogers WH, Ordway L, Greenfield S. Recall of recommendations and adherence to advice among patients with chronic medical conditions. *Archives of Internal Medicine*. 1993; 153(16):1869–1878. [PubMed: 8250648]

- Kusserow, RP. Medication regimens: Causes of noncompliance. Washington, DC: Office of Inspector General, US Department of Health and Human Services; 1990.
- Morisky DE, Ang A, Krousel-Wood M, Ward HJ. Predictive validity of a medication adherence measure in an outpatient setting. *Journal of Clinical Hypertension*. 2008; 10(5):348–354. [PubMed: 18453793]
- Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. *Medical Care*. 1986; 24(1):67–74. [PubMed: 3945130]
- Munger MA, Van Tassel BW, Lafleur J. Medication nonadherence: An unrecognized cardiovascular risk. *Medscape*. 2007; 9(3):58.
- National Center for Health Statistics. Hyattsville, MD: National Center for Health Statistics; 2008. Health, United States, 2008.
- National Institutes of Health. Face Sheet Self-management. 2006.
<http://www.nih.gov/about/researchresultsforthepublic/SelfManagement.pdf>
- Ong KL, Cheung BMY, Man YB, Lau CP, Lam KSL. Prevalence, awareness, treatment and control of hypertension among United States adults 1999–2004. *Hypertension*. 2007; 49(69):69–75. [PubMed: 17159087]
- Perreault S, Dragomir A, Roy L, White M, Blais L, Lalonde L, Bérard A. Adherence level of antihypertensive agents in coronary artery disease. *British Journal of Clinical Pharmacology*. 2010 Jan; 69(1):74–84. [PubMed: 20078615]
- Reed SD, Li Y, Oddone EZ, Neary AM, Orr MM, Grubber JM, Graham FL, Olsen MK, Svetkey LP, Dolor RJ, Powers BJ, Adams MB, Bosworth HB. Economic evaluation of home blood pressure monitoring with or without telephonic behavioral self-management in patients with hypertension. *American Journal of Hypertension*. 2010; 23(2):142–148. [PubMed: 19927132]
- Rosner F. Patient noncompliance: Causes and solutions. *Mt. Sinai Journal of Medicine*. 2006; 73(2): 553–559.
- Shea S, Misra D, Ehrlich MH, Field L, Francis CK. Correlates of nonadherence to hypertension treatment in an inner-city minority population. *American Journal of Public Health*. 1992; 82(12): 1607–1612. [PubMed: 1456334]
- Singer, JD.; Willet, JB. Applied longitudinal data analysis: Modeling change and event occurrence. New York: Oxford University Press; 2003.
- Thorpe CT, Bryson CL, Maciejewski ML, Bosworth HB. Medication Acquisition and Blood Pressure Control in Veterans with Hypertension. *Medical Care*. 2009; 47(4):474–481. [PubMed: 19330891]
- Wagner EH. The role of patient care teams in chronic disease management. *BMJ*. 2000; 320(7234): 569–572. [PubMed: 10688568]

Figure 1.
Change in SBP (mmHg) across 24 months by adherence at baseline

Figure 2.
Change in SBP (mmHg) by race and baseline medication adherence

Table 1**Patient Characteristics at Baseline**

	(n = 159)
Demographic	
Mean age (SD)	62 (12)
Race (%)	
White	45
African American	54
Other	2
Male (%)	36
Married (%)	51
Lives alone (%)	25
Completed ≤ 12 yr of school (%)	35
Low health literacy (%)	27
Employed (%)	36
Inadequate income (%)	20
No weekly exercise ≥ 20 min (%)	20
Current smoker (%)	18
Mean BMI (SD)	32.6 (8.5)
Medication non-adherence (%)	32
BP (mmHg)	
Controlled	72
Mean systolic BP (SD)	124 (18)
Mean diastolic BP (SD)	70 (10)