CONTINUITY OF CARE AND HYPERTENSION CONTROL IN A UNIVERSITY-BASED PRACTICE

Michael Fisher, MD; Philip Sloane, MD; Lloyd Edwards, PhD; George Gamble, PhD

Objectives: We describe the relationship between continuity of care and control of hypertension.

Design: Retrospective longitudinal cohort study of adults with hypertension.

Setting: University of North Carolina Family Medicine Center.

Patients: Hypertensive patients making at least four visits to the Center during a two-year period, 1999–2001.

Main Outcome Measures: Longitudinal blood pressure level and dichotomous (<140 systolic and <90 systolic) blood pressure control. Independent variables include continuity of care, race and other demographic information, type of primary provider, and insurance type.

Results: Both systolic and diastolic BP fell over the two years (systolic 2.2 mm Hg/year and diastolic 2.8 mm Hg/year). Lower systolic blood pressure was not associated with continuity of care, sex or provider type (faculty vs. resident). Lower diastolic blood pressure had a borderline association with continuity of care (2.2 mm Hg/year, 95% CI −4.7,0.4). Higher vs. lower continuity of care showed a trend toward better BP control, but the results were not significant (OR 0.84, 95% CI 0.65,1.09). Lower blood pressures were associated with Caucasian race (vs African American race).

Conclusions: Continuity of care was not related to control of hypertension at our center. The factors related to hypertension control need further research. (*Ethn Dis*. 2007;17:693–698)

Key Words: Hypertension, Health Disparities, African Americans, Continuity of Care, Longitudinal Data

From the Department of Family Medicine, University of North Carolina School of Medicine (MF, PS GG), Department of Biostatistics, School of Public Health (LE), University of North Carolina (LE), Chapel Hill, NC

Address correspondence to Michael-Fisher, MD; Department of Family Medicine, University of North Carolina School of Medicine; CB # 7595, Aycock Building; Chapel Hill, NC 27599; 919-966-4282; michael_fisher@med.unc.edu.

INTRODUCTION

Our ability to control hypertension in more than half the patients in primary care settings is lacking.[1–3] The process of recognizing that one has hypertension, locating and seeing a provider, getting a prescription, obtaining and taking the medicine regularly, and returning for followup to adjust the medication, is quite complex. The reasons for adherence and better control at each stage of the process are mostly uncertain, as well as how to motivate hypertensive patients to successfully modify lifestyle factors, which complement medication use. Considering that the prevalence of hypertension is ~50% by the sixth decade of life, blood pressure (BP) control in the community will require more understanding of these factors.

Continuity of care (COC) is one of the tenets of primary care.[4] COC may be defined operationally in a number of ways, including continuity of a patient and/or information within a system of care; the degree of transfer of medical information across providers and settings; continuous care by one provider or group of providers, be they specialists or sub-specialists; regular visits for the same condition; and the patient stating they have a usual provider or source of care.[5] While the value of COC has been debated in today's increasingly complex and fragmented healthcare system, prior studies have associated COC with patient[6,7] and provider satisfaction,[8,9] reduced emergency room use,[10,11] decreased hospital admissions for asthma[12] and general medical conditions,[13] better immunization rates,[14] and revelation of behavioral issues to providers.[15]

On the other hand, few studies have examined the relationship between COC and BP control. Data from 5886 patients interviewed for the Third National Health and Nutrition Examination Survey (NHANES) showed better control if patients saw the same provider or attended a single facility for most of their health care, but the degree of continuity was not measured in any way.[3] About 76% of those patients reported that they saw the same health provider for care and 87% went to the same health facility for care. In that cross-sectional study, control of BP was also correlated with recent BP determination or any lifestyle modification, such as weight loss, sodium reduction or exercise. In contrast, a recent study in England among eight practices with 560 patients showed that COC by provider had no effect on BP control.[16]

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This study explores the relationship between continuity of care by a single provider and hypertension control in a university family medicine center, controlling for type of provider, demographic information and insurance type.

METHODS

The study sample consisted of a retrospective longitudinal cohort of hypertensive patients seen for at least

four visits during the two-year period between January 1, 1999 and January 1, 2002 at a university-based family medicine center. Less than four BP determinations over a two-year period were considered to be too small a number to determine BP control and continuity. The center is located near the hospital and serves 15,000 patients in Orange and surrounding counties. A list of all 1106 patients who had visits during that time period with an ICD-9 hypertension diagnosis [401.xx to 405.xx] was obtained from practice billing records. From that population two samples were drawn. The original random sample was taken using randomly generated medical record numbers from all patients who had at least four of their visits coded with a hypertensive diagnosis (311 patients). Because that sample missed all the hypertensive patients who had made one to three visits with a hypertension code during that time, the second sample included the entire sample of patients with a hypertensive diagnosis recorded on at least one, but not more than 3 of the 4 or more visits (148 patients). All visits in both samples of patients were studied even if that visit did not include a hypertensive code or provider name. Initially the groups were analyzed separately; however the groups were later combined because both groups showed a similar lack of association between COC and BP control.

Each subject's medical record was reviewed to obtain data on age at first visit, race (determined by self-report), sex, insurance type, marital status, provider name and type (resident or faculty), and systolic and diastolic BP at each visit. In this paper, COC is defined as continuous care by one provider. Three continuity indices for each patient were measured to determine whether any of them showed a positive relationship between COC and BP control.[4,17,18] The indices were the Box and Bicerman formula, the Magill and Senf formula, and the Usual Provider Index. Measures range from .00 to 1.00 with 1.00 being perfect continuity.

Marital status was categorized as 'coupled' (living together or married) and 'uncoupled' (single, divorced or widowed). To reflect the different burden of costs of medications to the patient, insurance status was divided into co-pay ('third party'), Medicare, Medicaid, and 'none.' It was assumed that patients with Medicaid had nearly full payment for medicines, Medicare and 'none' had no payment for medicines, and third party insured patients had a deductible. If patients had more than one type of insurance, the insurance listing that was most likely to pay for medicines was used. No attempt in this study was made to record the dosage, type, or number of BP medicines used, because of lack of documentation in the progress notes and inaccuracies in the medication list when medications were filled outside the university pharmacies.

The practice routinely has a nurse or nursing aide measure BP at the beginning of a visit with the patient seated after a variable amount of time, using mercury sphygmomanometers or an automated machine (Dynamap). If the provider took one or more additional BP readings during a visit, a visit average was calculated (occurred in $<$10% of visits). If no BP was recorded, a visit was not included in the analysis. The study was approved by the institutional review board of the University of North Carolina.

Analysis

To include all the BP measurements from the two-year period, we performed a linear mixed model analysis in order to assess the association between longitudinal BP and BP control and the main predictors of interest: COC with the primary provider, demographic information, insurance type, and provider type. The linear mixed model provides estimation and hypothesis testing for simultaneously modeling population (fixed) and random (subject-specific) effects.[19,20] To ensure no higher order polynomial time effects existed, we initially tested for quadratic effects in time and the result was not statistically significant. Next, we tested for interaction of main effects and time (different slopes for different levels of main effects) and the results were not statistically significant. Hence, all linear mixed models assumed main effects only (slopes were parallel for different levels of main effects). For this study, we used random intercept and time for each subject. We assumed unstructured covariance for the random effects, and that given the random effects, the within-subject errors were independent and identically distributed with common scalar variance. All other covariates were used as fixed effects, including time and intercept. SAS v9.1 was used to perform all analyses.

We used the JNC-7 classification of BP control, if BP is $<$140/90 mm Hg. We created a binary outcome that indicates whether a person's BP was controlled or uncontrolled at the time of measurement. Thus, for each subject, we have longitudinal binary data indicating controlled or uncontrolled. We then fit a longitudinal logistic regression using generalized estimating equations[19,21] to this data to determine BP control over time.

RESULTS

A total of 459 hypertensive patient charts were reviewed. The patient characteristics are noted in Table 1. The patients were mostly White or African American, female, married, had third party insurance, visited about 10 times over the two years, and saw a faculty provider. The mean COC index for these patients was .56, .76 and .71 using the Box and Bicerman formula, the Magill and Senf formula, and the Usual Provider Index, respectively (Table 1). These results show, for

Table 1. Characteristics of the study subjects: 459 patients with hypertension

Characteristic	*N*	%	Mean (SD)
AGE	459		58.9 (14.84)
RACE			
White	243	53	
African American	205	45	
Asian	9	2	
Other	2	0.4	
SEX			
Female	283	62	
Male	176	38	
MARITAL			
Married	255	56	
Widowed	77	17	
Single	62	14	
Divorced	53	12	
Cohabiting	12	3	
INSURANCE			
Medicare	47	10	
Medicaid	49	11	
Co-pay	337	73	
None	22	5	
PROVIDER			
Faculty	324	71	
Resident	131	29	
VISITS	4762		10.4 (5.66)
COC INDICES			
Box and Bicerman	459		0.56 (0.290)
Magill and Senf	459		0.76 (0.190)
UPI	459		0.71 (0.214)
SYSTOLIC BP	459		143.7 (14.86)
DIASTOLIC BP	459		81.2 (8.41)

SD=standard deviation, COC=continuity of care, BP=blood pressure.

each formula, that with an average of 10 visits over 2 years, about seven were made to the same provider. Overall, the mean systolic BP was 143.7 and the mean diastolic pressure was 81.2. Using the JNC-7 definition of controlled BP, 47% of all patient visits had controlled BP during the study period. Both men and women had their BP controlled during 47% of their visits. Only 3% of patients (14/459) had BP controlled over all visits to the center. Among White patients, BP was controlled in 48% of the visits vs 45% of African American patient visits.

Both systolic and diastolic pressures changed significantly during the two year period. The decrease was 2.2 mm Hg for systolic and 2.8 mm Hg for diastolic, per year. The initial mean systolic pressure for African Americans was 145.6 mm Hg vs 142.6 mm Hg in Whites (P=.0619 for the difference between the two) with both dropping significantly during the two-year period. Similarly, African Americans had higher beginning mean diastolic pressures (84.5 vs 81.9, P=.0036) and pressure in both groups dropped significantly.

Using any of the three formulas, COC was not associated with either systolic or diastolic BP either as a continuous variable, or dichotomized into controlled (<140 systolic and <90 diastolic) vs uncontrolled. Thereafter, we analyzed relations between COC and the other variables using only the Box and Bicerman formula. In the linear mixed model, an unadjusted analysis, which included the interaction of COC and time on BP, systolic BP dropped 2.8 mm Hg/year (95% CI −7.0,1.4, P=.19) and diastolic BP dropped 1.8 mm Hg/year (95% CI −4.0,0.3, P=.09). When the COC score was divided into tertiles, (.0–.39=low COC, .40–.66=medium COC, and .67–1.0=high COC), high COC was .84 times as likely as low COC to be uncontrolled (CI .65–1.09) over time (2 years), high COC was .95 as likely as medium COC to be uncontrolled (CI .73–1.23), and medium COC was .88 times as likely as low COC to be uncontrolled (CI .67–1.16). (Table 2)

Using a linear mixed model, age had a significant effect on systolic and diastolic BP, raising it in systolic and lowering it in diastolic BP, but the effects were small (Table 3). African American race contributed significantly to poorer systolic and diastolic BP. The other variables, including sex, marital status, insurance type and provider type had no significant effects on longitudinal BP.

DISCUSSION

BP is notoriously difficult to control, a fact that is reinforced by our data. Despite an average of 10 visits during two years, good COC, mostly insured patients, and experienced faculty providers conducting 80% of the visits, we were able to achieve adequate longitudinal control of BP in only 47% of our patients. We had originally hypothesized that our Family Medicine Center would have low continuity of care because residents and faculty are part-time, averaging two to five half-day sessions per week with absences for inpatient and off-site work. We thought if COC were improved, it might lead to better BP control. Continuity of care, however, was relatively high and BP control was only average, comparable to recent NHANES data, which examines people in their home or in mobile centers. In the 1999–2000 NHANES data set, 53% of treated hypertensives had their BP controlled[3] compared to our 47%. In contrast to our data,

Table 2. Effect of unadjusted continuity of care on blood pressure control

Effect	Estimate*	SE	*P* value	OR (95% CI)
Intercept	.7	.1	<.0001	
BP change/yr	−.3	.1	<.0001	
COC (Med vs low)	−.1	.1	.3714	.88 (0.68, 1.16)
COC (High vs Low)	−.2	.1	.1985	.84 (0.65, 1.09)
COC (High v. med)	−.05	.1	.7130	.95 (0.95, 1.23)

* mm Hg.

however, the NHANES data is not longitudinal.

Of all the relationships we tested, including COC, sex, race, age, insurance, type of provider, number of visits, and marital status, only age and African American race had a relationship to both systolic and diastolic BP level, with African American race contributing to higher BP. Dividing COC into tertiles did show a trend toward better control of BP with high vs low COC, although the results were not significant. It is possible, however, that a larger sample could show improved control of BP, although the effect may be small. The expected relationships between age and systolic BP (raising the BP), and age and diastolic BP (lowering it), were found.[22]

These results differ from other studies, which have shown an association between COC and blood pressure. Yet, prior studies have used different measures of continuity. One used the question of the patient: "Do you receive health care from the same provider or facility?"[3] Two other studies also used cross-sectional data[23,24] and showed that a recent healthcare visit (<6 months prior) related to better BP control. In our study, however, despite the fact that subjects had an established diagnosis of hypertension, were in treatment and made at least four visits in 2 years, COC was marginally related to BP control. The Inkster study[16] is consistent with our results showing a lack of association. Similar conflicting results have been reported in diabetes care; some studies reported better glucose control with higher continuity[25,26] while another showed

Table 3. Longitudinal data results using linear mixed model assessing all main effects

Blood Pressure	Effect	Estimate*	SE (95% CI)	*P* value
Systolic BP	Intercept	128.5	3.75 (121.1, 135.8)	<.0001
	BP change/year	−2.2	.60 (−3.4, −1.0)	.0003
	Age	.2	.05 (0.1, 0.3)	<.0001
	Race (Black vs White)	3.9	1.37 (1.3, 6.6)	.0004
	Race (Other vs White)	−2.7	4.36 (−11.2, 5.9)	.5395
	Sex (Female vs Male)	1.6	1.39 (−1.1, 4.3)	.2555
	Marital status†	.9	1.44 (−1.9, 3.8)	.5193
	Provider‡	−1.8	1.52 (−4.7, 1.2)	.2474
	Insurance§	2.3	2.13 (−1.9, 6.5)	.2759
	Insurance‖	1.5	2.55 (−3.5, 6.5)	.5481
	Continuity score	−1.6	2.39 (−6.4, 3.1)	.4916
Diastolic BP	Intercept	96.1	2.03 (92.1, 100.1)	<.0001
	BP change/year	−2.8	.30 (−3.4, −2.2)	<.0001
	Age	−.2	.02 (−0.3, −0.2)	<.0001
	Race (Black vs White)	2.1	.74 (0.6, 3.5)	.0053
	Race (other vs White)	−2.1	2.36 (−6.7, 2.5)	.3773
	Sex (female vs male)	−.5	.75 (−2.0, 1.0)	.5055
	Marital status†	−.7	.78 (−2.2, 0.8)	.3670
	Provider‡	−1.2	.82 (−2.8, 0.4)	.1337
	Insurance§	.6	1.15 (−1.7, 2.9)	.6083
	Insurance‖	−.7	1.38 (−3.4, 2.0)	.6069
	Continuity score	−2.2	1.30 (−4.7, 0.4)	.0938

* In mm Hg.
† Married or coupled (0) vs single, divorced, or widowed (1).
‡ Resident (1) vs Faculty (0).
§ Third party (1) vs. Medicaid (0).
‖ Medicare and no insurance (1) vs. Medicaid (0).

Of all the relationships we tested…only age and African American race had a relationship to both systolic and diastolic BP level, with African American race contributing to higher BP

no relationship between continuity of provider and the process measures of receiving a glycosylated hemoglobin test or eye exam.[27]

The study has several limitations. It was performed in one academic health center and in one primary care clinic and may not apply to other centers or a random community population. The number of patients in the study was modest. The population chosen, with at least four visits over a two-year period, had a moderate degree of continuity with the center to begin with and increments above that may not show a difference in BP control. Other, simpler measures of continuity, which do show a relationship to BP control, such as ''do you have a regular provider or usual source of care'' may be measuring care vs no care, in which it would be expected to see a difference in BP control. BP control in those studies was only about 50% as well. The most useful construct of COC is not known,[28] and it might be helpful to compare, in the same population, COC obtained by asking patients about their continuity, to their actual visits with providers.

Once a patient is in treatment, it seems that other factors must have more influence on longitudinal control of BP. While not investigated in this study, prescription purchase, adherence to, and number and type of medications likely have a role. Also not examined in this study, but increasingly recognized, is the reluctance of providers to treat mild hypertension[29] and isolated systolic hypertension.[30] Furthermore, the study did not measure patient satisfaction,[31] trust in provider or provider race, knowledge of hypertension, or attitudes about having or treating a chronic disease,[32] all of which could have an impact on lifestyle changes and medication taking behavior. To better understand the answers to these questions, we are continuing to study factors associated with BP control.

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REFERENCES

1. Berlowitz D, Ash A, Hickey R, et al. Inadequate management of blood pressure in a hypertensive population. *N Engl J Med*. 1998;339:1957–1963.
2. Knight EL, Bohn RL, Wang PS, Glynn RJ, Mogun H, Avorn J. Predictors of uncontrolled hypertension in ambulatory patients *Hypert*. 2001;38:809–814.
3. He J, Muntner P, Chen J, Roccella EJ, Streiffere RH, Whelton PK. Factors associated with hypertension control in the general population of the United States. *Arch Intern Med*. 2002;162:1051–1058.
4. Committee on the future of primary care. *Primary Care: America's Health in a New Era*. 1st Ed. Washington, DC: Institute of Medicine - National Academy of Sciences; 1996.
5. Starfield B. Longitudinality and Managed Care. In Starfield B ed. *Primary Care*. New York, NY: Oxford University Press; 1992: 41–87.
6. Hjortdahl P, Laerum E. Continuity of care in general practice: effect on patient satisfaction. *BMJ*. 1992;304:1287–1290.
7. Alpert JJ, Robertson LS, Kosa J, Haggerty MC, Haggerty RJ. Delivery of health care for children: report of an experiment. *Pediatrics*. 1976;57:917–930.
8. Becker MH, Drachman RH, Kirscht JP. A field experiment to evaluate various outcomes of continuity physician care. *Am J Public Health*. 1974;64:1062–1070.
9. Guhrie B, Wyke S. Does continuity in general practice really matter? *BMJ*. 2000;321: 734–736.
10. Christakis DA, Mell L, Koepsell TD, Zimmerman FJ, Connell FA. Association of lower continuity of care with greater risk of emergency department use and hospitalization in children. *Pediatrics*. 2001;107:524–529.
11. Love MM, Mainous AG III, Talbert JC, Hager GL. Continuity of care and the physician-patient relationship on the importance of continuity for adult patients with asthma. *J Fam Pract*. 2000;49:998–1004.
12. Gill JM, Mainous AG III. The role of provider continuity in preventing hospitalizations. *Arch Fam Med*. 1998;7:352–357.
13. Wasson JH, Sauvigne AE, Mogielnicki RP, et al. Continuity of outpatient medical care in elderly men: a randomized trial. *JAMA*. 1984;252:2413–2417.
14. Christakis DA, Mell L, Wright JA, Davis R, Connell FA. The association between greater continuity of care and timely measles-mumps-rubella vaccine. *Am J Public Health*. 2000;90: 962–965.
15. Becker MH, Drackman RH, Kirscht JP. Continuity of pediatrician: new support for an old shibboleth. *J Pediatr*. 1974;84:599–605.
16. Inkster M, Montgomery A, Donnan P, Macdonald T, Sullivan F, Fahey T. Organizational factors in relation to control of blood pressure: an observational study. *BJ Gen Pract*. 2005;55:931–7.
17. Bice TW, Boxerman SB. A quantitative measure of continuity of care. *Med Care*. 1977;15:347–349.
18. Magill M, Senf J. A new method for measuring continuity of care in family practice residencies. *J Fam Pract*. 1987;24:165–168.
19. Edwards LJ. Modern statistical techniques for the analysis of longitudinal data in biomedical research. *Pediatric Pulmonology*. 2000;30: 330–344.
20. Laird NM, Ware JH. Random-Effects Models for Longitudinal Data. *Biometrics*. 1982;38: 963–974.
21. Diggle PJ, Liang KY, Zeger SL. *Analysis of Longitudinal Data*. Oxford: Clarendon Press; 1994.
22. Kannel WB, Gordon T. Evaluation of cardiovascular risk in the elderly: the Framingham study. *Bull NY Acad Med*. 1978;54: 573–591.
23. McClellan WM, Hall WD, Brogan D, Miles C, Wilber JA. Continuity of care in hypertension. An important correlate of blood pressure control among aware hypertensives. *Arch Intern Med*. 1988;148:525–528.
24. Phillips DM, Shear CL. Provider continuity and control of hypertension. *J Fam Pract*. 1984;19:793–797.

25. Parchman ML, Pugh JA, Noel PH, Larme AC. Continuity of care, self-management behaviors, and glucose control in patients with type 2 diabetes. *Med Care*. 2002;40: 137–144.
26. O'Conner PJ, Desai J, Rush WA, Cherney LM, Solberg LI, Bishop DB. Is having a regular provider of diabetes care related to intensity of care and glycemic control? *J Fam Pract*. 1998;47:290–297.
27. Gill JM, Mainous III AG, Diamond JJ, Lenhard MJ. Impact of provider continuity on quality of care for persons with diabetes mellitus. *Ann Fam Med*. 2003;1:162–170.
28. Saultz JW. Defining and measuring interpersonal continuity of care. *Ann Fam Med*. 2003;1:134–143.
29. Berlowitz D, Ash A, Hickey R, et al. Inadequate management of blood pressure in a hypertensive population. *N Engl J Med*. 1998;339:1957–1963.
30. Hyman D, Pavlik V. Self-reported hypertension treatment practices among primary care physicians: blood pressure thresholds, drug choices, and the role of guidelines and evidence-based medicine. *Arch Intern Med*. 2000;160:2281–2286.
31. Nutting PA, Goodwin MA, Flocke SA, Zyzanski SJ, Stange KC. Continuity of primary care: to whom does it matter and when? *Ann Fam Med*. 2003;1:149–155.
32. Jokisalo E, Kumpusalo E, Enlund H, Takala J. Patients' perceived problems with hypertension and attitudes towards medical treatment. *J Hum Hypertens*. 2001;15: 755–761.

AUTHOR CONTRIBUTIONS

Design concept of study: Fisher, Sloane, Gamble
Acquisition of data: Fisher, Gamble
Data analysis and interpretation: Fisher, Sloane, Edwards, Gamble
Manuscript draft: Fisher, Sloane, Edwards, Gamble
Statistical expertise: Edwards, Gamble
Acquisition of funding: Fisher, Edwards, Gamble
Administrative, technical, or material assistance: Fisher, Sloane, Edwards, Gamble
Supervision: Fisher, Sloane, Edwards, Gamble