

Impact of Poorly Controlled Hypertension on Healthcare Resource Utilization and Cost

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Objective: To examine the relation between blood pressure (BP) control and utilization and cost of healthcare resources.

Study Design: A retrospective database study of managed care patients in New Mexico from January 1, 1996, to December 31, 1997.

Patients and Methods: We stratified 1000 hypertensive patients into categories based on average and maximum BP. Antihypertensive medication use and cost, number of physician visits, and interval between hypertension-related physician visits were determined.

Results: Medication costs increased progressively across all BP categories from lowest to highest, and higher average systolic BP (SBP) was significantly correlated with increased cost ($P < .001$). There were significant correlations between higher maximum BP and greater number of hypertension-related physician visits ($P < .001$). Mean number of visits for BP groups was 5.5 for patients with a maximum diastolic BP (DBP) < 85 mm Hg and 10.0 for those with a maximum DBP ≥ 100 mm Hg ($P < .001$). Patients with a maximum SBP ≥ 180 mm Hg averaged 9.7 visits, whereas those with a maximum SBP < 120 mm Hg averaged 4.1 visits ($P < .001$). Both SBP and DBP were significantly correlated with time to next visit ($P < .001$). Mean visit intervals ranged from 44 days for patients with an SBP < 85 mm Hg to 25 days for those with an SBP ≥ 180 mm Hg ($P < .001$). A similar association was found between DBP and visit interval.

Conclusions: Poor control of hypertension is associated with higher drug costs and more physician visits. Aggressive treatment might help reduce managed care costs and resource utilization.

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Hypertension is the most prevalent cardiovascular disorder in the United States, affecting nearly 50 million people, or more than 20% of the adult population.¹ Defined as systolic blood pressure (SBP) higher than 140 mm Hg and/or diastolic blood pressure (DBP) higher than 90 mm Hg, hypertension is a major risk factor for stroke, coronary heart disease, kidney disease, and heart failure.² Despite the well-documented relation between high blood pressure (BP) and increased morbidity and mortality, only 69% of hypertensive patients are aware of their condition; of those who are aware, only 53% are treated, and only 45% of those treated have their BP under control.³

The long-term goal of hypertension management is to prevent cardiovascular disease. In the short term, this requires significant use of healthcare resources. The 1999 total cost of treating hypertension in the United States was estimated to be \$33.3 billion.⁴ Direct costs of medical care included \$8.1 billion for drugs, \$7.7 billion for healthcare providers, \$7.1 billion for hospital and nursing home care, and \$1.5 billion for home healthcare and other medical durables. The cost of lost productivity resulting from hypertension-related morbidity and mortality was \$8.8 billion. Although these costs

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seem high, the 1999 cost in the United States of treating heart disease and stroke, common sequelae of untreated and uncontrolled hypertension, has been estimated to be \$286.5 billion dollars.⁴

The cost of short-term resource utilization by hypertensive patients depends on several factors, such as the frequency of physician visits, the interval between visits, the acquisition costs of drugs, and patient adherence to prescribed therapy. Schwartz and colleagues⁵ found that little guidance was available to assist physicians in timing follow-up visits; as a result, their recommendations for office revisits varied widely. Several studies^{6,7} have linked shorter visit intervals with higher BP, suggesting that patients with poorly controlled or more severe hypertension might incur higher costs than those with controlled hypertension.

Patient nonadherence to antihypertensive drug therapy can also increase the cost of hypertension care. Rizzo and Simons⁸ found that hypertensive patients who were at least 80% adherent had lower total healthcare costs than less adherent patients. Another study⁹ reported that 86% of patients in a Medicaid population interrupted or discontinued their antihypertensive medication use during the first year of therapy, resulting in additional annual costs of \$873 per patient compared with those who were adherent.

Studies of resource utilization among hypertensive patients conducted so far have focused on specific populations, such as Veterans Administration patients,⁷ and, therefore, the results might not be generalizable to the managed care setting. In this study, we examine the relation between different degrees of BP control and antihypertensive medication cost and use, number of physician visits, and interval between hypertension-related physician visits in a managed care setting.

... PATIENTS AND METHODS ...

Design

A retrospective study of a cohort of hypertensive patients was conducted at Lovelace Health System, Albuquerque, NM, a fully integrated healthcare delivery system and mixed staff/network-model health maintenance organization (HMO) in the southwestern United States. The time horizon for the study was 1 year.

Patient Population

One thousand health plan members with hypertension were randomly selected according to the fol-

lowing criteria: (1) 40 years or older as of January 1, 1996; (2) one or more outpatient encounters in 1996 with a diagnosis of hypertension (*International Classification of Diseases, Ninth Revision, Clinical Modification*¹⁰ [ICD-9-CM] codes 401, 401.0, 401.1, and 401.9); (3) continuous enrollment (defined as not having a break of greater than 45 days during the study window) in the health plan from January 1, 1996, to December 31, 1997; and (4) at least one BP reading in 1997 recorded in the medical chart. Patients were excluded from the cohort if they had a diagnosis of secondary hypertension or pregnancy in 1996 or 1997 (ICD-9-CM diagnosis codes 405, 405.x, V22.x, V23.x, and V24.x) or if they were participating in a clinical trial during 1997. More than 98% of health plan members have prescription drug benefits. In 1997, most members paid \$5 to \$10 for generic drugs and \$10 to \$15 for brand-name drugs.

Patients who satisfied these criteria were stratified in 2 ways. First, patients were divided into 5 BP groups based on the Joint National Commission on the Management of Hypertension (JNC VI) guidelines.² Two of the 5 groups represented controlled hypertension and 3 represented uncontrolled hypertension. Patients were placed in a group based on their average BP reading. Multiple measurements taken from a patient on the same day were averaged (SBP and DBP readings were averaged separately) to yield 1 measurement for that day. All BP measurements taken during 1997 were averaged for each patient to yield a mean value for the year.

Second, patients were classified based on their maximum DBP and SBP during the study. This approach was taken to determine whether mean number of hypertension-related office visits and mean visit interval differed according to maximum BP.

Data Collection

Healthcare utilization data for the cohort were extracted from electronic enrollment and claims records housed in the Managed Care Database of the Southwest Center for Managed Care Research, Lovelace Respiratory Research Institute, Albuquerque, NM. These data were from January 1, 1997, to December 31, 1997, and included all claims and encounter data related to hospital admissions, outpatient examinations and procedures, and outpatient pharmacy fills. Key data elements extracted included dates of service, ICD-9-CM diagnosis codes, procedure codes, procedure charges, service location, admission and discharge dates for hospital stays, drug names, drug doses, and drug therapeutic

classes. Full-text medical records of the cohort were reviewed by a nurse medical record reviewer and 2 trained assistants, and data concerning risk factors and BP readings were extracted. All reviewers were trained to follow a detailed abstraction protocol that was developed and pilot tested specifically for use in this study. In addition, all reviewers were supervised throughout the study, and a sample of their records was reabstracted by the nurse to ensure accuracy. In a previous study at the health plan, claims data were found to have a positive predictive value of 86% for identifying hypertensive patients when full-text medical records were used as the gold standard (Covance Health Economics and Outcomes Services, unpublished observations, 1998).

Resource Costing

Only costs of antihypertensive drugs were considered in this study. The average wholesale price of each drug was obtained from the Multum Lexicon.¹¹ The acquisition cost of each prescription fill was calculated based on the product and dose dispensed. The cumulative drug cost per patient was determined by summing the acquisition costs for all prescription fills received during the study.

Data Analyses

Variability in (1) antihypertensive medication use, (2) antihypertensive medication cost, (3) mean number of physician visits, and (4) interval between physician visits was determined for the cohort. For each group in the average BP stratification, number of drugs prescribed and drug cost were determined, and means and standard deviations (SDs) were calculated. Outcome measures for the maximum BP stratification included the mean number of visits for each maximum SBP and DBP group and the time to next visit based on maximum SBP and DBP at a given visit. Patients without antihypertensive drug use were included in all of the visit analyses, as were patients with drug use. Because distribution of ambulatory visits, days between those visits, and medication costs are often skewed, the nonparametric Kruskal-Wallis and Brown-Mood (for median values) tests were used to examine differences across different BP categories.

Correlation coefficients were calculated to assess the significance of the relation between maximum BP and number of visits, maximum BP and time to next visit, and average BP and medication cost.

Medication adherence was determined by calculating a medication possession ratio (MPR).¹² The

MPR is defined as the number of days the drug was supplied to the patient divided by the number of days in the treatment period. The ideal MPR would be 100%, indicating that the drug was supplied for every day in the treatment period. The number of days in the treatment period was defined as the number of days from the date of first dispensing of a drug in a given therapeutic class to the date of last dispensing of a drug in that same class. This process yielded 1 MPR per therapeutic class for each patient. The MPRs were then averaged for all therapeutic drug classes taken by a patient to determine a single MPR for that patient.

The likelihood of having a subsequent physician visit was modeled as a function of BP control at the previous visit using Cox proportional hazards regression. The dependent variable was the time interval between visits. The principal independent variables were DBP and SBP readings at the previous visit. Other independent variables included patient ethnicity, patient adherence as measured by the MPR, number of antihypertensive medications received by the patient, and case mix. The Ambulatory Care Group Case-Mix Adjustment System method categorizes patients into clinically similar groups based on age, sex, and *ICD-9-CM codes*.¹³ We chose to include in the regression model a subset of Ambulatory Care Group categories that occurred most frequently in the study population (**Table 1**). Only visits in which BP was recorded were included in the Cox regression.

A logistic regression model was used to determine the absolute probability of a patient's BP not being controlled at any given visit based on lack of BP control at the previous visit. To compute the absolute probability, we used the following equation based on output from the logistic regression:

$$\text{Probability of not being controlled} = 1 - [\exp(b_0 + b_1x_1 + \dots + b_nx_n) / (1 + \exp(b_0 + b_1x_1 + \dots + b_nx_n))]$$

where $b_1..b_n$ are the parameter estimates for each of the independent variables included in the logistic regression model. The dependent variable was control (1 = Yes, 0 = No) at visit N, and the principal independent variable was control at visit N-1. Other independent variables included patient ethnicity, MPR, number of antihypertensive medications received by the patient, and case mix. Control was defined as SBP less than 140 mm Hg and DBP less than 90 mm Hg. A threshold of .05 (2 tailed) was used for statistical significance.

All statistical analyses were run using the SAS® Statistical Software Package for Personal Computers, Version 6.12 (SAS Institute Inc, Cary, NC).

Assumptions

An office visit for this cohort was considered to be hypertension related if any of the following conditions were met: (1) a BP reading was taken, (2) the visit was to a general practitioner or an internal medicine or cardiovascular specialist, or (3) the primary diagnosis code associated with the visit was for hypertension.

Table 1. ACG Categories Occurring Most Frequently in the Study Population

ACG Code	Description
ACG900	Chronic medical, stable
ACG2300	Acute minor and chronic medical, stable
ACG3600	Acute minor/acute major/likely to recur/eye and dental
ACG4100	2-3 Other ADG combinations, age >34 y
ACG4910	6-9 Other ADG combinations, age >34 y, 0-1 major ADGs
ACG4920	6-9 Other ADG combinations, age >34 y, 2 major ADGs
ACG5040	10+ Other ADG combinations, age >16 y, 0-1 major ADGs
ACG5050	10+ Other ADG combinations, age >16 y, 2 major ADGs
ACG5060	10+ Other ADG combinations, age >16 y, 3 major ADGs
ACG5070	10+ Other ADG combinations, age >16 y, 4+ major ADGs

ACG = Ambulatory Care Group; ADG = Ambulatory Diagnosis Group.

Table 2. Demographic and Clinical Characteristics of Hypertensive Patients

Characteristic	Value (SD) (N = 1000)
Demographic	
Mean age, y	65.1 (12.3)
Male, %	44.0
Hispanic origin, %	30.8
Clinical	
Mean diastolic BP, mm Hg	82.5 (8.4)
Mean systolic BP, mm Hg	140.3 (15.5)
JNC VI classification, %*	
Controlled BP, mm Hg	
<130/85 (normal)	19.2
130/85 to 139/89 (high normal)	25.3
Uncontrolled BP, mm Hg	
140/90 to 159/99 (stage 1)	43.9
160/100 to 179/109 (stage 2)	10.3
≥180/110 (stage 3)	1.3
Patients with at least one JNC VI risk factor, % [†]	80.8

BP = blood pressure; JNC VI = Joint National Committee on the Detection, Evaluation and Treatment of High Blood Pressure.

*Based on average BP during the study.

[†]JNC VI risk factors include smoking, dyslipidemia, diabetes mellitus, age (>60 years), sex (men and postmenopausal women), and family history of cardiovascular disease.

... RESULTS ...

Population

The mean ± SD age of the cohort was 65.1 ± 12.3 years, and 44% were men (Table 2). According to the JNC VI classification of high BP, 55.5% of patients did not have their BP controlled based on average BP during the study.

Drug Treatment

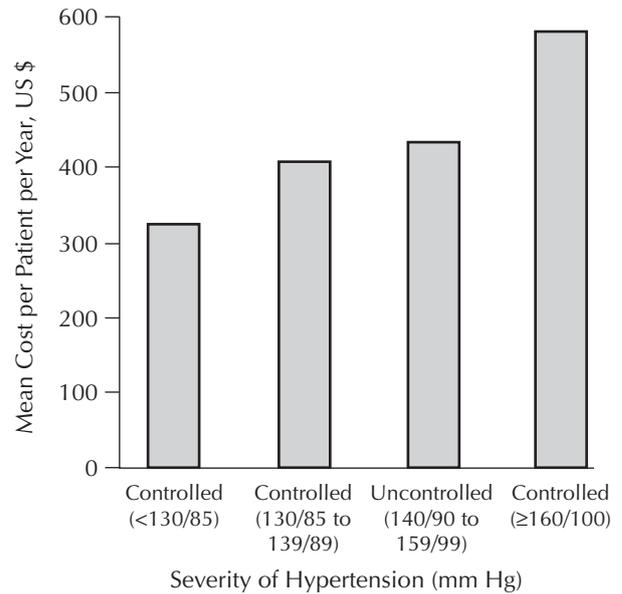
Angiotensin-converting enzyme inhibitors were prescribed at least once for 39.3% of the study population, making them the most commonly prescribed antihypertensive agents. Calcium channel blockers were almost as popular at 32.4%, followed by diuretics (32.1%) and β-adrenergic blocking agents (15.3%). The least prescribed class of agents was angiotensin receptor antagonists (4.7%). Antihypertensive agents not belonging to one of the 5 major therapeutic classes were considered together because individually they were rarely prescribed. There were 182 patients (18.2%) who received no antihypertensive drugs during the study. There was no statistical difference between the groups receiving and not receiving medication in terms of age or severity of hypertension; the group not receiving any medication included a disproportionate number of men (52% male vs 42% female; *P* < .05).

The proportion of agents from each therapeutic class prescribed for each BP group is described in Table 3. (The top 2 uncontrolled groups are combined because of the small numbers of

patients in each group.) Although the total number of prescription fills in each group was similar, ranging from 10.6 to 11.9, the proportions of drug fills from the different therapeutic classes varied according to BP. Calcium channel blockers were more commonly prescribed for patients with BP greater than 130/85 mm Hg compared with controlled hypertensive patients having BP less than 130/85 mm Hg ($P < .01$). Angiotensin receptor antagonists were more commonly prescribed in the groups with the highest BP compared with controlled groups with BP less than 130/85 mm Hg ($P < .05$). An average of 1.4 different therapeutic classes of hypertensive agents were prescribed per patient.

There was a progressive increase in medication costs across all BP categories from lowest to highest (Figure 1). In addition, average SBP was significantly correlated with medication cost ($P < .001$). Well-controlled patients with average BP less than 130/85 mm Hg incurred mean \pm SD costs of $\$325.92 \pm \308.01 . Costs increased to $\$407.66 \pm \408.55 for patients in the 130/85 to 139/89 mm Hg controlled group. Patients in the 2 uncontrolled groups, 140/90 to 159/99 mm Hg and $\geq 160/100$ mm Hg, incurred mean \pm SD costs of $\$430.76 \pm \410.93 and $\$577.95 \pm \631.88 , respectively. Mean costs were significantly different across all groups ($P < .001$). Median costs were $\$304$, $\$333$, $\$352$, and $\$430$ for the 4 BP categories, respectively (the difference across groups missed the threshold of statistical sig-

Figure 1. Cost of Medication in Each Average Blood Pressure Category



$P < .001$ across groups based on the nonparametric Kruskal-Wallis test.

Table 3. Mean Number of Prescription Fills in Each Average Blood Pressure Category

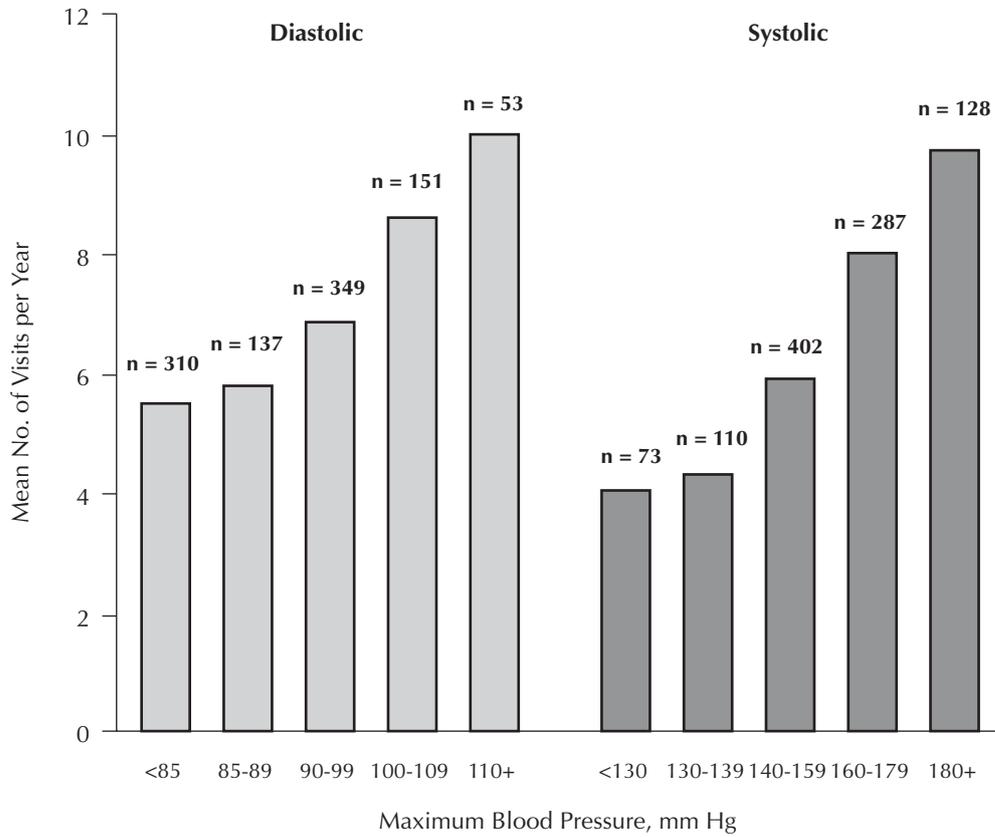
JNC VI Classification	Mean (SD) No. of Prescription Fills									Total
	VAS	SYM	ACE	ARA	CCB	AI	BB	DIU	Misc	
Normal (n = 192)	0.67 (2.5)	0.22 (1.5)	3.6 (5.3)	0.21 (1.6)	1.8 (4.3)	0.0	1.5 (3.8)	2.7 (4.6)	0.0	10.6
High normal (n = 253)	0.56 (2.2)	0.48 (2.1)	3.7 (5.5)	0.44 (2.3)	3.0* (5.0)	0.04 (0.6)	1.4 (3.7)	2.2 (4.3)	0.0	11.9
Stage 1 (n = 439)	0.93 (3.1)	0.43 (2.2)	3.5 (5.3)	0.30 (1.6)	3.2* (5.1)	0.0	1.2 (3.4)	2.2 (4.1)	0.06 (0.8)	11.8
Stage 2 or 3 (n = 116)	1.07 (3.2)	0.68 (3.3)	3.1 (4.7)	0.48† (2.1)	3.7* (5.4)	0.18 (1.3)	1.0 (3.4)	1.7 (3.4)	0.09 (1.1)	11.9

JNC VI = Joint National Committee on the Detection, Evaluation and Treatment of High Blood Pressure; VAS = vasodilators; SYM = sympatholytic agents; ACE = angiotensin-converting enzyme inhibitors; ARA = angiotensin receptor antagonists; CCB = calcium channel blockers; AI = adrenergic inhibitors; BB = β -adrenergic blocking agents; DIU = diuretics; Misc = miscellaneous.

*Compared with the normal group, statistically significant difference ($P < .01$) based on the nonparametric Mann-Whitney U test.

†Compared with the normal group, statistically significant difference ($P < .05$) based on the nonparametric Mann-Whitney U test.

Figure 2. Mean Number of Physician Visits According to Maximum Diastolic and Systolic Blood Pressure



n = number of patients.
P < .001 across groups based on the nonparametric Kruskal-Wallis test.

Table 4. Median Number of Visits and Median Visit Interval for Patients Based on Maximum Blood Pressure Categories

Maximum Blood Pressure Category	Median No. of Visits		Median Visit Interval, d	
	SBP	DBP	SBP	DBP
<130/85 mm Hg	4	5	28	27
130/85 to 139/89 mm Hg	3.5	5	28	26
140/90 to 159/99 mm Hg	5	6	28	28
160/100 to 179/109 mm Hg	7	7	21	19
≥180/110 mm Hg	8	8	19.5	15
Significance across groups	<i>P</i> < .001	<i>P</i> < .001	<i>P</i> < .01	<i>P</i> < .001

SBP = systolic blood pressure; DBP = diastolic blood pressure.

nificance based on the nonparametric Brown-Mood median score test) (*P* = .09).

Adherence to drug therapy as calculated by the MPR was split into 3 levels: 0% to 29%, 30% to 79%, and 80% and higher. Most patients (61.7%) were at the 80% and higher adherence level, whereas 21.4% were 0% to 29% adherent and 16.9% were 30% to 79% adherent. No significant correlation was found between MPR and BP control.

Physician Visits

Patients in the study made a mean ± SD of 6.7 ± 5.2 hypertension-related visits during the study. A record of the BP was noted at a

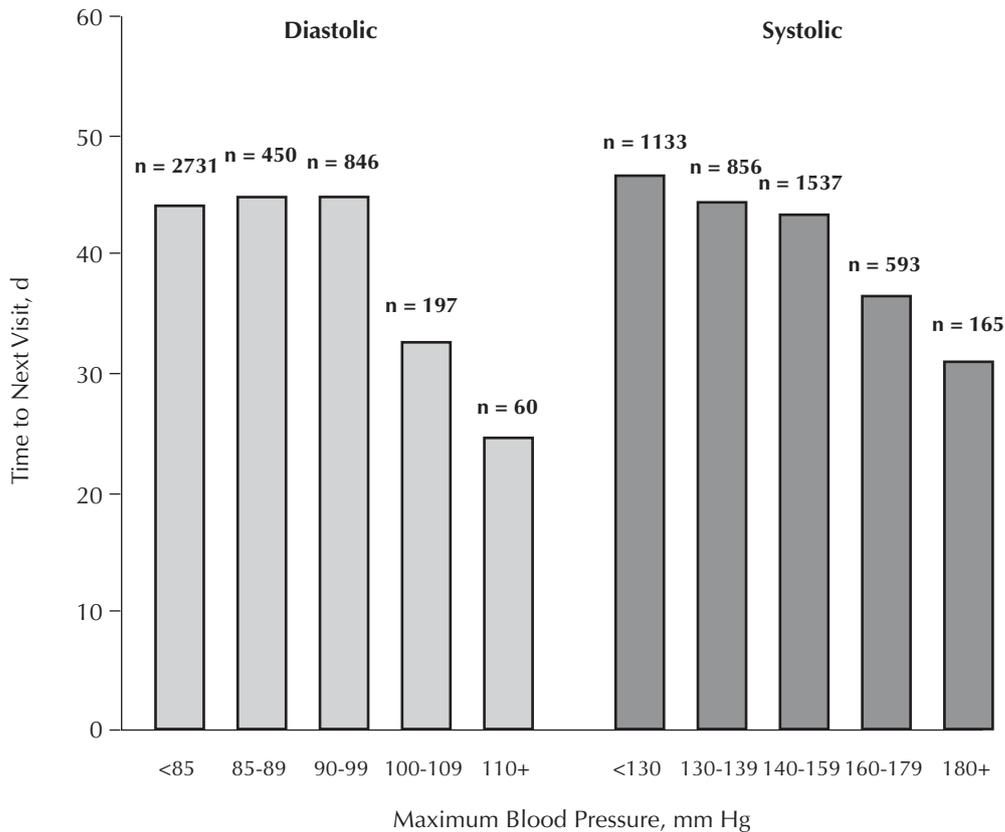
mean \pm SD of 5.1 ± 3.8 of these visits. Maximum DBP and maximum SBP readings during 1 year were significantly correlated with the number of hypertension-related physician visits during that period ($P < .001$) (Figure 2). In addition, based on the Kruskal-Wallis test, mean results were significant across all groups for maximum SBP and DBP ($P < .001$). Patients with a maximum DBP of 110 mm Hg or greater had a mean \pm SD of 10.0 ± 6.8 visits compared with 6.9 ± 4.7 visits for patients with a maximum DBP of 90 to 99 mm Hg and 5.5 ± 4.1 visits for patients with a maximum DBP <85 mm Hg. Patients with a maximum SBP of 180 mm Hg or greater for the study period had a mean \pm SD of 9.7 ± 6.5 visits vs 5.9 ± 4.1 visits for patients with a maximum SBP of 140 to 159 mm Hg and 4.3 ± 3.2 visits for patients with a maximum SBP of 130 to 139 mm Hg. Analysis of visit count based on median SBP and DBP values also showed that the difference across BP groups

was statistically significant ($P < .001$ for both SBP and DBP) based on the nonparametric Brown-Mood median score test (Table 4).

Elevated SBP was more common than elevated DBP. At 54% of visits, patients had SBP values greater than the JNC VI target of 140 mm Hg, whereas DBP values were greater than the target level of 90 mm Hg at only 26% of visits. The proportion of patients with at least 1 visit in which SBP was 160 mm Hg or greater was 41.5%.

Both SBP and DBP were significantly correlated with time to next visit ($P < .001$). Figure 3 illustrates that elevated BP at any hypertension-related physician visit was associated with a reduction in the time interval to the next visit. For visits in which the DBP was less than 85 mm Hg, the mean \pm SD time to the next visit was 44 ± 46 days. Visit intervals for patients with higher DBP readings were significantly shorter. Patients with a DBP of 100 to 109 mm Hg

Figure 3. Interval Between Physician Visits Based on Maximum Diastolic and Systolic Blood Pressure



n = number of visits.
 $P < .001$ across groups based on the nonparametric Kruskal-Wallis test.

had 33 ± 44-day visit intervals, whereas patients with a DBP of 110 mm Hg or higher had 25 ± 32-day visit intervals. Mean visit intervals were significantly different across DBP groups ($P < .001$).

Mean visit intervals were also shorter with higher SBP ($P < .001$ across groups). Visits with an SBP of 140 to 159 mm Hg were associated with a mean ± SD visit interval of 44 ± 47 days, whereas the interval was 37 ± 43 days for an SBP of 160 to 179 mm Hg and 32 ± 38 days for an SBP of 180 mm Hg or greater. Differences across groups based on median visit interval were also significant ($P < .01$ for SBP and $P < .001$ for DBP) (Table 4).

Cox regression showed that SBP was a predictor of future visits (Table 5). With all other factors held constant, a 1-unit increase in a patient's SBP at the previous visit was associated with a 0.2% greater likelihood of having another hypertension-related visit during which BP was recorded ($P = .018$). Using the model parameter estimates to predict visit intervals, a person with SBP of 140 mm Hg at a previous visit had a 2% greater likelihood of having a hypertension-related visit within 30 days than a person with SBP of 150 mm Hg. Other significant correlates

of future visits included number of different antihypertensive medications a patient received ($P < .001$) and Hispanic origin ($P = .012$). Ambulatory Care Group categories were also strongly correlated with future visits.

The logistic regression results indicated that when controlling for other factors, a person was 2.7 times more likely to have his or her BP controlled at any given visit when under control at the previous visit. Using these results, the absolute probability of not being controlled at the next visit, if not under control at the previous visit, was calculated to be .69 (Table 6). Based on BP levels recorded at each visit, patients with uncontrolled BP at any given visit required 3 subsequent visits to achieve control.

... DISCUSSION ...

This study was based on data from the real-world experience of hypertensive patients in a managed care health system. These data show that there is a significant association between increased BP and

(1) higher cost of antihypertensive medications, (2) greater number of hypertension-related office visits, and (3) shorter physician visit intervals. Although it is appropriate for clinicians to see patients with poor control more frequently and to treat them with more expensive medications, the costs of poor control can be substantial.

The cost of medication is the largest direct medical expense in hypertension treatment, accounting for 33% of total direct costs in the United States in 1999.⁴ In our study, medication costs were greater in groups with uncontrolled BP. Because the number of prescriptions in each group was similar, differences in prescribing patterns explain the differences in costs between the groups. Calcium channel blockers were more commonly prescribed for patients with higher BP, perhaps because they are indicated for elderly patients and those with isolated systolic hypertension.² Overall, angiotensin-converting enzyme inhibitors and calcium

Table 5. Results of Cox Regression Model Predicting Likelihood of Next Physician Visit

Variable	Parameter Estimate	P	Risk Ratio
ACG900	-0.953	<.001	0.385
ACG2300	-0.686	<.001	0.504
ACG3600	0.152	.040	1.164
ACG4100	-0.484	<.001	0.616
ACG4910	0.211	<.001	1.234
ACG4920	0.305	<.001	1.357
ACG5040	0.647	<.001	1.910
ACG5050	0.644	<.001	1.904
ACG5060	0.918	<.001	2.503
ACG5070	0.697	<.001	2.008
Hispanic origin	0.085	.012	1.089
MPR	0.012	.762	1.012
Number of medications	0.145	<.001	1.156
Previous diastolic reading	0.001	.422	1.001
Previous systolic reading	0.002	.018	1.002

ACG = Ambulatory Care Group; MPR = medication possession ratio.

channel blockers were the most commonly prescribed antihypertensive agents in this study. Patients receiving these drugs tend to be more adherent than those taking other antihypertensive medications,¹⁴ an observation that might explain the high adherence rates seen in our study.

Our finding that higher BP in hypertensive patients results in shorter visit intervals is in agreement with several other studies. In a study of 800 elderly hypertensive men receiving care at Veterans Administration medical centers, Berlowitz and colleagues⁷ found that lower BPs were significantly associated with longer intervals between visits. Lichtenstein and colleagues⁶ examined medical records during 14 years for a cohort of hypertensive patients ranging from 27 to 85 years old and reported a similar finding. They further noted that the age and sex of the patient did not affect this relation. Our results are in line with JNC VI guidelines,² which suggest a shorter follow-up interval for more severely hypertensive patients. Better BP control seems to lead to less resource utilization and a consequent reduction in treatment costs. Assuming an average physician visit cost of \$60,¹⁵ study results indicate that the difference of 5.6 visits per year between a controlled patient (maximum SBP <130 mm Hg) and a patient with poor control (maximum SBP ≥180 mm Hg) could translate into savings of \$340 per person per year.

In our study, SBP, but not DBP, was a predictor of future physician visits. In addition, SBP was higher than the JNC VI target of 140 mm Hg at 54% of visits, whereas DBP was higher than the target of 90 mm Hg at only 26% of visits. This finding is in agreement with data from the Third National Health and Nutrition Examination Survey study, which reported that 73% of hypertensive patients are at or below their DBP goal, whereas only 34% are at or below their SBP goal.¹⁶ In addition, SBP has shown to be more predictive of future cardiovascular disease than DBP,¹⁷ and treating patients with isolated systolic hypertension leads to significant reductions in cardiovascular morbidity and mortality.^{18,19} The prevalence of isolated systolic hypertension is increasing along with the proportion of our

older population,¹⁹ suggesting that more attention should be directed at controlling SBP levels.

This study is principally based on data derived from medical claims databases, which might be incomplete or contain coding errors; these databases are usually designed for reimbursement purposes, and health plan financial incentives can affect prioritizing claim diagnoses. Although clinical data were gathered from medical records to supplement these data, the information obtained was limited and full details about patient comorbidities were not available. Thus, all physician visits might not have been solely hypertension related. Including visits that were not hypertension related, however, would introduce noise into the data, with a bias toward the null. The relation between hypertension and number of visits was significant despite this. Often, databases are used to gather proxy measures for studies, implying outcomes. This study, however, primarily used direct measures (number of visits, interval between visits, and BP measurement), and only one proxy measure (dispensed drugs) was used to evaluate adherence. This adds a level of confidence to the results derived from retrospective database analysis.

Table 6. Results of Logistic Regression Model Determining the Absolute Probability of a Patient's BP Not Being Controlled at Any Given Visit Based on Lack of BP Control at the Previous Visit

Variable	Parameter Estimate	P	Odds Ratio
ACG900	-0.665	.915	1.039
ACG2300	0.173	.587	1.189
ACG3600	-0.240	.094	0.786
ACG4100	0.004	.979	1.004
ACG4910	0.0002	.998	1.000
ACG4920	0.163	.157	1.177
ACG5040	-0.004	.971	0.996
ACG5050	0.233	.061	1.262
ACG5060	0.163	.202	1.177
ACG5070	0.049	.756	1.050
Hispanic origin	0.015	.818	1.015
MPR	0.085	.273	1.088
Number of medications	-0.163	<.001	0.849
Previous control	0.983	<.001	2.671

BP = blood pressure; ACG = Ambulatory Care Group; MPR = medication possession ratio.

Although the patients included in this study were randomly selected from all hypertensive patients meeting the study criteria, no control group of non-hypertensive patients was included, and the average age (65.1 years) was high. In addition, the population was 30% Hispanic, a larger proportion than is found in the general US population, although normal for the territory served by this HMO. Because 25% of non-Hispanic blacks and 24% of non-Hispanic whites with hypertension have their BP under control, but only 14% of Mexican Americans do,² the data presented here might not be generalizable to other patient populations.

Previous studies^{8,9,12} have shown the importance of patient adherence in terms of hypertension control and treatment cost. In our study, most patients were at least 80% adherent. However, we did not explore the impact of adherence levels on resource use.

Finally, this study assessed treatment patterns, resource utilization, and BP outcomes for hypertensive patients but did not consider other influences on treatment, such as physician knowledge of or adherence to hypertension guidelines. Nor did we assess the quality of care received by this patient population. Although this information would be interesting to obtain, and quality of care certainly has an impact on patient outcomes and cost of care, it was beyond the scope of this study.

... CONCLUSION ...

The results of this study indicate that better BP control is associated with lower managed care resource utilization even when only short-term outcomes are evaluated. Better control of hypertension might result in lower drug costs and less frequent physician visits. Future investigation should consider the impact of controlling hypertension on other resources, such as hospitalization and emergency department visits.

Although hypertension is one of the most common reasons for a visit to a physician in the United States,²⁰ many hypertensive patients remain poorly controlled. In this study, patients with uncontrolled BP, particularly high SBP, visited physicians more frequently. Without more aggressive hypertension treatment, healthcare resource utilization will continue to increase. The aging population is growing, and many older individuals will develop isolated systolic hypertension. This will certainly add to the short-term economic burden of this condition. In the long term, poorly controlled hypertension is likely to result in costly and debilitating cardiovascular disease.

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