Control of Cardiovascular Risk Factors in Patients With Diabetes and Hypertension at Urban Academic Medical Centers

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OBJECTIVE — There are national mandates to reduce blood pressure (BP) to <130/85 mmHg, LDL cholesterol to <100 mg/dl, and HbA_{1c} to <7% and to institute aspirin therapy in patients with diabetes. The objective of this study was to determine the proportion of patients in urban institutions with diabetes and hypertension who meet these treatment goals.

RESEARCH DESIGN AND METHODS — Using American Diabetes Association (ADA) guidelines, we evaluated the control of cardiovascular disease (CVD) risk factors in 1,372 patients receiving medical care at two major urban medical centers in Brooklyn and Detroit. Information was extracted from charts of outpatient clinics.

RESULTS — Of 1,372 active clinic patients with diabetes and hypertension, 1,247 (90.9%) had type 2 diabetes, and 26.7% met the target blood pressure of 130/85 mmHg. A total of 35.5% met the goal LDL cholesterol level of <100 mg/dl, 26.7% had an HbA_{1c} <7%, and 45.6% were on antiplatelet therapy. Only 3.2% of patients met the combined ADA goal for BP, LDL cholesterol, and HbA_{1c}.

CONCLUSIONS — Optimal control of CVD risk factors in adults with diabetes was achieved only in a minority of patients. Results reflect the inherent difficulties in achieving these complex guidelines in our present health care systems.

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Prevalence of type 2 diabetes is increasing dramatically because of population aging and a rising prevalence of obesity and sedentary lifestyle in our society (1–3). Middle-aged individuals with type 2 diabetes who have yet to develop cardiovascular disease (CVD) events have been reported to have the same risk of fatal or nonfatal myocardial infarction as those without diabetes who have already experienced CVD events (4). In the U.K. Prospective Diabetes Study, the major risk factors for CVD in type 2 diabetes were hypertension, hyperglycemia, increased LDL cholesterol, low levels of HDL, and smoking (5,6).

Whereas the effect of tight blood glucose control on CVD risk is modest (6,7), rigorous treatment of hypertension strikingly reduces macro- and microvascular events (5,8,9). Aggressive treatment of dyslipidemia in type 2 diabetes also reduces CVD to a greater extent than in those without diabetes, as shown in secondary (10) as well as primary prevention trials (11–13). Aspirin therapy has also been shown to reduce CVD events in patients with type 2 diabetes (14).

As more information on the control of CVD risks in patients with diabetes becomes available from clinical trials, the American Diabetes Association (ADA) and other organizations have continually updated its practice guidelines and treatment goals (15–17). For example, a blood pressure (BP) goal of 130/85 mmHg, recommended by the Joint National Committee on Prevention VI (15), has been reduced to <130/80 by the ADA (17) and the National Kidney Foundation in their new treatment recommendations (18).

Currently, the ADA treatment goal for LDL cholesterol in patients with diabetes is generally 100 mg/dl or less, regardless of the presence or absence of established coronary heart disease (CHD) (19). Aspirin therapy is also recommended by the ADA as a secondary prevention strategy in individuals with concomitant diabetes and CVD and also for primary prevention in those at risk, including diabetic patients >30 years of age, obese patients, or those with hypertension or hyperlipidemia (20). These groups constitute the majority of patients with type 2 diabetes.

Despite continued revision of treatment goals and update to the guidelines of the ADA and other organizations regarding the management of CVD risk factors, there are no extant data, except for a small report (21) and the National Health and Nutrition Examination Study (NHANES)-III study from 1991–1994 (22), regarding the achievement of such goals and the adherence to these guidelines. Therefore, between July 1999 and July 2000, using the ADA guidelines, we assessed care provided to

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Abbreviations: ADA, American Diabetes Association; BP, blood pressure; CHD, coronary heart disease; CVD, cardiovascular disease; DBP, diastolic blood pressure; HMG, hydroxymethylglutaryl; NHANES, National Health and Nutrition Examination Study; SBP, systolic blood pressure; SUNY, State University of New York; VAMC, Veteran Affairs Medical Center; WSU-UHC, Wayne State University–University Health Center.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Demographic characteristics and risk factors control by hospital source*

	VAMC Brooklyn	SUNY Brooklyn	VAMC Detroit	WSU-UHC Detroit	Total
n	474	218	371	309	1,372
Age (years)	68.5 ± 0.5 (38–93)	55.5 ± 0.9 (25–91)	64.4 ± 0.6 (34–90)	64.6 ± 0.7 (24–96)	64.5 ± 0.33 (24–96)
Sex					
Male	47 (99.4)	85 (39)	368 (99.2)	99 (32)	1,023 (74.6)
Female	3 (6)	133 (61)	3 (0.8)	210 (68)	349 (25.4)
BMI (kg/m^2)	29.9 ± 0.2	32.1 ± 1.0	31.3 ± 0.3	32.1 ± 0.4	31 ± 0.29
BP (mmHg)					
Systolic	138 ± 0.8	147 ± 1.5	145 ± 1.2	145 ± 1.3	143 ± 0.6
Diastolic	77 ± 0.5	79 ± 0.7	76 ± 0.7	80 ± 0.7	78 ± 0.3
Pulse pressure	61 ± 0.7	68 ± 1.4	69 ± 1.0	65 ± 1.0	63 ± 0.5
BP ≤130/85 mmHg	171 (36)	35 (16.1)	91 (24)	68 (22)	365 (27)
SBP >130 mmHg and DBP <85 mmHg	205 (43)	117 (54)	189 (51)	149 (48)	660 (48)
SBP >130 mmHg and DBP <85 mmHg	16 (3.4)	10 (4.6)	1 (0.3)	9 (2.9)	36 (2.6)
BP >130/85 mmHg	81 (17)	55 (25)	90 (24)	82 (27)	308 (22)
LDL ≤100 mg/dl	159 (37)	11 (28)	92 (34)	92 (36)	354 (36)
LDL 101–130 mg/dl	164 (38)	7 (18)	93 (34)	88 (34)	352 (35)
LDL 131–160 mg/dl	76 (18)	16 (41)	58 (22)	42 (16)	192 (19)
LDL >160 mg/dl	30 (7.0)	5 (13)	27 (10)	37 (14)	99 (10)
HbA_{1c} ≤7%	30.3	16.7	16.6	40.1	26.7
HbA_{1c} 7–8%	27.3	19.2	21.9	21.1	23.2
HbA_{1c} 8–9%	21.4	18.2	28.1	14.0	21.0
HbA_{1c} ≥8%	42.4	64.0	61.5	38.8	50.0
HbA_{1c} ≥9%	21.0	45.8	33.4	24.7	29.0

Data are means ± SE (range), means ± SE, *n* (%), and %.

patients with concomitant diabetes and hypertension at two major urban academic institutions and their associated Veteran Administration (VA) Hospitals. As primary outcome measures of our study, we assessed the control of hypertension, dyslipidemia, hyperglycemia, and the use of antiplatelet therapy.

RESEARCH DESIGN AND METHODS

Before initiation, this cross-sectional study was approved by the institutional review boards of Wayne State University (Detroit) and State University of New York (SUNY) at Brooklyn. Active adult clinic patients with concomitant diabetes and hypertension were identified by outpatient diagnostic billing codes and medical records at Veteran Affairs Medical Center (VAMC) at Brooklyn and Detroit, Kings County Hospital/SUNY, and Wayne State University–University Health Center (WSU-UHC). Patients not seen for over 1 year or followed for <1 year were excluded. Information was then extracted from the chart and transferred to a standardized form for data collection. Data for each institution was then entered into a database using the same coding at a central location.

Data analysis

Data were analyzed using a cross tabulation method to examine the proportion of patients at each institution and also for the whole group that met ADA goals for the control of CVD risk factors. These goals included BP <130/85 mmHg, LDL <100 mg/dl, and HbA_{1c} <7%. The proportion of patients on ACE inhibitors or aspirin, those who smoked, and those who consumed >8 oz of alcohol per day was also determined. To assess the difference among institutions for continuous variables (e.g., age, BMI, HbA_{1c}, LDL, and BP), ANOVA with Tukey's post hoc analysis was used. Data analysis was performed using the statistical software program SPSS Version 8 (SPSS, Chicago, IL).

RESULTS

Demographics

A total of 1,372 patients with concomitant diabetes and hypertension were identified at the sites as follows: 474 patients (34.5%) received care at the Brooklyn VAMC, 218 (16.0%) at SUNY-Brooklyn, 371 (27.5%) at the Detroit VAMC, and 309 (19.6%) at WSU-UHC. The mean age for the cohort was 64.5 years (range 24–96), and 1,023 patients (74.6%) were men, reflecting the disproportionate male predominance at the VAMCs. In other urban institutions, the male/female distribution showed a higher number of female patients (Table1). In addition, 90.9 and 9.1% of patients had type 2 and type 1 diabetes, respectively. The mean BMI of our cohort was 31 kg/m^2.

Patients in Detroit had a higher mean BMI than those in Brooklyn (31.6 vs. 30.1 kg/m^2) (P <0.001) (Table 2). Patients at the two VA centers were older, with a mean age of 66.7 vs. 60.8 years for patients at the two other urban clinics (P < 0.001) (Table 3). There was no difference in mean BMI of men followed at the VA system (30.4 kg/m^2) compared with men followed at the other urban institutions (29.9 kg/m^2) (P = 0.62). In addition, 18.3% of the cohort had a diagnosis of CHD, 7.7% had a history of stroke and/or transient ischemic attack, and 9.9% had peripheral vascular disease.

Control of cardiovascular risk factors

Hypertension. All together, 26.7% of our entire cohort met a treatment goal BP of 130/85 mmHg; 25.6% met the 2001

Table 2—*Comparing adult diabetic patients from two urban locations*

	Urban New York diabetic patients	Urban Detroit diabetic patients	*P*
n	692	680	
Age (years)	64.4 ± 0.47	64.5 ± 0.44	NS†
BMI (kg/m^2)	30.1	31.6	<0.01†
SBP (mmHg)	141 ± 0.76	145 ± 0.86	0.01†
DBP (mmHg)	78 ± 0.41	78 ± 0.50	NS†
BP <130/85 mmHg	29.9	23.2	0.01‡
LDL cholesterol (mg/dl)	113 ± 1.4	118 ± 1.9	0.01†
LDL cholesterol <100 mg/dl	36.2	34.6	NS‡
HbA_{1c} (%)	8.31 ± 0.08	8.33 ± 0.08	NS†
HbA_{1c} <7%	28.4	28.7	NS‡

Data are means ± SE and %. †Independent Student *t* test; ‡χ^2 analysis.

ADA BP target of 130/80. For the entire cohort, mean systolic BP (SBP) was 143 mmHg, diastolic BP (DBP) was 78 mmHg, and pulse pressure was 63 mmHg (Table 1). Patients in Detroit had a higher mean SBP (145 mmHg) than those treated in Brooklyn (141 mmHg) ($P = 0.01$) (Table 2). The percentage of patients from Brooklyn who met the BP goal of 130/85 was higher than that from Detroit (29.9 vs. 23.4%, $P = 0.01$). Categorization of BP levels was based on the ADA treatment goals for hypertension in diabetes at the time of the study (23). The majority of the patients (48%) had inadequately treated systolic hypertension (SBP >130 mmHg); 22.5% had an elevation in both SBP and DBP, and only 2.6% had inadequately controlled DBP (Table 1).

Dyslipidemia. A total of 35.5% met the goal of LDL cholesterol <100 mg/dl; 35.3% had LDL cholesterol between 101 and 130 mg/dl, 19.3% had LDL cholesterol between 131 and 160 mg/dl, and 9.9% had LDL cholesterol >160 mg/dl (Table 1). Although the mean LDL cholesterol was higher at the two Detroit centers (118 mg/dl) than at the Brooklyn center (113 mg/dl), there was no difference in the percentage that achieved the goal LDL cholesterol of <100 mg/dl (Table 2). Patients at the VAMC had lower LDL cholesterol (113 mg/dl) than those at other clinics (119 mg/dl) ($P = 0.01$) (Table 3).

Glycemic control. All together, 96% of this cohort had a measurement of HbA_{1c} done within a year. Of those, only 26.7% met the ADA goal of HbA_{1c} <7%, 23.2% had HbA_{1c} values at 7–8%, 21% had values at 8–9%, and 29% had values >9%. Overall, 50% had an HbA_{1c} >8% (Table 1). There were no differences in glycemic control between the patients followed at Detroit and those followed at Brooklyn centers (Table 2). Patients followed at VAMC had a lower mean HbA_{1c} (8.2%) than those from non-VA institutions (8.4%) ($P < 0.001$) (Table 3).

Obesity. Only 17% of patients had a BMI <25 kg/m^2, and 48.2% were obese, with a BMI >30 kg/m^2. Women had a higher BMI (33.1 kg/m^2) than men (30.4 kg/m^2) ($P = 0.01$). Patients in Detroit centers had a higher BMI (31.6 kg/m^2) than those in Brooklyn (30.1 kg/m^2) (Table 2). The mean BMI of men at the VAMC (30.2 kg/m^2) was similar to that of the men at other urban institutions (30.4 kg/m^2) ($P = 0.09$).

Other health care measures

Dilated eye exam. Dilated eye exam within the previous year was accomplished in 69.6% of the patients. This is slightly higher than recently reported in the Diabetic Retinopathy Awareness Program (DRAP) population (24). VAMC patients were more likely to have an ophthalmologic exam than those at other institutions (72.2 vs. 62.2%) ($P < 0.01$) (Table3), and 72.3% of men versus 60.6% of women had dilated eye exams ($P < 0.001$).

Microalbuminuria. Only 56.3% of the patients had a measurement for proteienuria.

Smoking. Fifteen percent of patients were current smokers, and values were higher for men (17%) than women (7%) ($P < 0.01$). There was also a higher proportion of smokers among men at VAMC (18%) than at other institutions (9%) ($P < 0.01$). Smoking history was not obtained in 26% of the entire cohort.

Alcohol use. Eleven percent of the entire cohort used >8 oz of alcohol per day, whereas 5% used that quantity of alcohol in the past. There was a lower proportion of alcohol users at VAMC (9%) than at other urban institutions (14%) ($P = 0.05$).

Medication use

Antiplatelet agents. Of our cohort, 46% were treated with antiplatelet agents, 35% with 325 mg/day aspirin, 9.3% with 81

Table 3—*Comparing VA versus urban institutions*

	VA medical centers	Urban academic centers	*P*
n	845 (62)	527 (38)	
Age (years)	66.7 ± 0.4	60.8 ± 0.6	<0.01*
HbA_{1c} (%)	8.2 ± 0.1	8.4 ± 0.1	<0.01*
LDL cholesterol (mg/dl)	113 ± 1.3	119 ± 2.7	0.01*
SBP (mmHg)	146 ± 0.9	141 ± 0.7	NS*
DBP (mmHg)	76 ± 0.4	79 ± 0.5	NS*
BP <130/85 mmHg	31.0	19.6	<0.01†
Patients on an antiplatelet agent	51.4	37.1	<0.01†
Patients on ACE inhibitors	66.6	60.2	0.02†
Patients on HMG-CoA reductase inhibitors‡	40.1	34.9	0.03†
Patients referred for yearly retinal examination	74.2	62.2	<0.01‡

Data are *n* (%), means ± SE, and %. *Independent *t* test; †χ^2 analysis; ‡3-hydroxy-3-methylglutaryl. NS, not significant.

mg/day aspirin, and 1.1% with other agents (clopidogrel, ticlopidine, or dipyridamole). Of those on aspirin, 42.7% received the low-dose 81-mg formulation. Patients at the VAMC were more likely to receive antiplatelet agents than those from other institutions (51.4 vs. 37.4%, $P < 0.01$) (Table 3). In all, 35.8% of women and 49.3% of men were on antiplatelet agents ($P < 0.01$). This was, in part, due to the greater use of antiplatelet therapy in the two VAMCs.

Antihypertensive agents. The mean number of medications required to achieve a goal BP of 130/85 mmHg was 3.1. Those with BP >130/85 mmHg were receiving 3.3 medications, and those with SBP <130 mmHg and DBP >85 mmHg were on 2.4 medications. The most commonly used drugs were ACE inhibitors (64.1%), calcium channel blockers (43.6%), diuretics (37.0%), β-blockers (20.8%), and α-blockers (10.7%). The least used were centrally acting adrenergic agents (5.7%), angiotensin II receptor blockers (3.6%), and vasodilating agents (2.6%). Of patients who achieved BP <130/85 mmHg, 72.4% were receiving a combination of two or more drugs for hypertension, and 22.2% of the patients received a fixed-dose combination therapy.

ACE inhibitors. Of the patients treated with ACE inhibitors, 66.6% were from the two VAMCs, and 60.2% were from other sites ($P = 0.02$) (Table 3). Women were less likely to be on ACE inhibitors than men (65.9 vs. 59.0%, respectively) ($P = 0.02$). This gender difference in ACE inhibitor therapy was, in part, due to greater use of these drugs in the VAMC.

Lipid-lowering agents. All together, 41.3% patients were on lipid-lowering drugs, and 38.1% were receiving a hydroxymethylglutaryl (HMG)-CoA reductase inhibitor, 3.9% a fibrate, and 0.6% a bile acid binding resin. Use of a fibrate was associated with a lower triglyceride level (mean 163 vs. 317 mg/dl, $P < 0.01$). Lipid therapy was more likely among those with higher LDL cholesterol levels (>130 mg/dl), and only 40% of the patients with LDL cholesterol of 101–130 mg/dl were on a lipid-lowering agent, whereas more than two-thirds of those with LDL cholesterol >160 mg/dl received treatment.

Antidiabetes agents. Among patients with type 2 diabetes treated with pharmacological agents for hyperglycemia, 63.2% received sulfonylureas, 39.4% insulin, 30.4% metformin, 20.3% acarbose, and 2.9% thiazolidinediones. In addition, 76.6% of patients with HbA_{1c} <7% were on combination therapy.

Comprehensive care

Only 3.2% of patients met the combined ADA goal for BP, LDL cholesterol, and HbA_{1c}. Those who met all of these goals and were also treated with aspirin were 1.9% of the cohort studied, and 8.5% met both the BP and LDL cholesterol targets, 8.3% achieved the goal BP and HbA_{1c}, and 7.4% met both the lipid and the glycemic goals.

CONCLUSIONS

This cohort of patients with concomitant diabetes and hypertension were older and predominantly men; ~50% had BMI >30 kg/m^2. The lower percentage of smokers (14%) than the reported 26–28% for the adult American population, reflects either the effect of counseling on smoking cessation, as recommended by the ADA (25), or the decline in the prevalence of smoking with disease duration (26). Of our cohort, 18% had documented CHD, 7.7% had stroke or transient ischemic episodes, and 10% had a peripheral vascular disease. These observations reinforce the notion that patients with diabetes often have other concomitant CVD (2,3).

That 26.7% of this cohort was treated to the recommended BP of 135/85 mmHg was consistent with NHANES data indicating that <30% of the general hypertensive population was treated to a goal of 140/90 mmHg. Data from the Beaver Dam Eye Study indicated that hypertension was even less often controlled to levels <139/89 mmHg in patients with diabetes compared with those without diabetes (27). Our data suggest that recommendations for aggressive lowering of BP in patients with diabetes (15–17,23) is often not translated into clinical practice. Inadequate treatment in our cohort largely reflected the lack of SBP control to <130 mmHg.

Randomized prospective clinical trials have shown that rigorous treatment of BP in patients with diabetes reduces macrovascular as well as microvascular disease (5,9,28). The average number of antihypertensive medications required to achieve a target BP of 130/85 mmHg was 3.1, consistent with data from five large clinical trials, where the average number of medications used to achieve target BP in diabetic subjects was 2.6–4.3 (29). These observations support the notion that patients with diabetes require multiple antihypertensive medications in order to achieve lower BP targets.

Currently, the ADA recommends that HbA_{1c} be monitored twice yearly if glycemic control is stable or at least quarterly when treatment changes or if glycemic goals are unmet (17). Of our patients, 96% had HbA_{1c} measured at least once in the previous year, which very favorably compares with other studies (30). Only 26.7% of our cohort had an HbA_{1c} <7%, and 50% had an HbA_{1c} >8%. This is slightly worse than the mean HbA_{1c} of 7.8% that is reported in type 2 diabetes in NHANES III (22). These results suggest that treatment of hyperglycemia should be more diligently addressed.

Treatment of LDL cholesterol in diabetes shows striking reductions in CVD morbidity and mortality (31). In the present cross-sectional analysis, 35% of subjects had LDL cholesterol levels <100 mg/dl and another 35% between 101 and 130 mg/dl. Only one-third had LDL cholesterol levels >130 mg/dl. This compares favorably to the NHANES III study, where 15.4% had LDL cholesterol values <100 mg/dl, and another 33.9% had values at 100–129 mg/dl (22). Our data suggest that the more recent guidelines of lower LDL cholesterol are being translated into practice.

As suggested by the results of the U.K. Prospective Diabetes Study (32) and by the ADA (20), adult individuals with diabetes with evidence of any CVD should receive aspirin, and >99% of those patients are candidates for aspirin therapy (33). Our data suggests that this guideline was not met in >50% of the patients. However, as estimated from NHANES III, during 1998–1994, only 20% of adults with diabetes received aspirin therapy (33). Given that the ADA diabetes-specific guidelines for aspirin therapy were not published until 1997, the higher prevalence of aspirin use among our patients (46%) suggests better translation of the ADA recommendations into clinical practice.

Despite the particularly high risk of CVD among women with diabetes and the significant reductions in CVD with aspirin therapy (9,14), women in our study were less likely than men to receive aspirin. This observation is consistent with previous reports indicating that aspirin therapy in adults (with or without diabetes) was less prevalent in women than men (34,35).

There were differences in the demographic characteristics of the diabetic populations followed at the two urban communities. Patients in Detroit had greater obesity and higher SBP than those in Brooklyn. These observations may reflect the strong relationship between systolic hypertension and obesity (3). The greater BP control rate in Brooklyn may reflect the lesser degree of elevation of SBP and the difficulty in controlling this BP component as previously observed in an older VA population (36).

In contrast to a previous report of poorly controlled hypertension from a VA population (36) (data collected between 1990–1995), our data suggests that an older group of patients with diabetes and hypertension followed at two VA centers actually received a more comprehensive approach than younger patients followed at university clinics. Besides the differences in the study populations, where only 34% of the patients in the previous report were diabetic, implementation of the new ADA practice guidelines developed since 1995 and extensive computerization of the health care system that took place over the past decade at VAMCs are possible explanations of the better results in the VA system in the current study. Indeed, care provided at the VA outpatient centers resulted in lower HbA_{1c} and lower LDL cholesterol levels and a higher proportion of patients achieving the BP goal of 130/85 mmHg. VA patients were also more likely to be on ACE inhibitors, HMG-CoA reductase inhibitors, and aspirin therapy and to have dilated eye exams. This suggests that care in a national system, which has recognized standards and goals for treatment of various risk factors may result in better control of CVD. Access to free medical care pharmaceuticals also explains the better results in the VA system. Compared with the NHANES III population, all of our subjects were receiving at least some form of ongoing medical care. With the exception of glycemic control, a higher proportion of our cohort were in compliance with the guidelines. However, only a very small group (3.2%) had all CVD risk factors addressed comprehensively. Multiple factors could explain this very low rate, including the complex and challenging nature of diabetes management and the low reimbursement rate. A short patient encounter does not adequately provide the time necessary for addressing patient motivation and adherence to complex care behaviors and continued assessment for optimum therapeutic effectiveness or lack of enthusiasm among health care providers to rigorously follow the recommendations. Our results indeed underscore the difficulty in achieving complex guidelines in our present health care systems. Finally, we would like to emphasize that, with the "outcome" measures of diabetes care being the primary objective of our study, several questions regarding the "process" behind such outcome remain to be answered. And because both the process and the outcome, as aspects of the quality of care are closely related, such questions deserve further studies to help formulate suggestions for improving diabetes care.

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