High Rates of Co-occurrence of Hypertension, Elevated Low-Density Lipoprotein Cholesterol, and Diabetes Mellitus in a Large Managed Care Population

Joe V. Selby, MD, MPH; Tiffany Peng, MS; Andrew J. Karter, PhD; Mark Alexander, PhD; Stephen Sidney, MD, MPH; Jean Lian, PhD; Amy Arnold, MS; and Dan Pettitt, DVM, MS

Objective: To examine prevalence and co-occurrence of diabetes mellitus (DM), hypertension (HT), and elevated low-density lipoprotein cholesterol (dyslipidemia, or DL) in a managed care population.

Study Design: Period prevalence study.

Patients and Methods: The study population included all adults (age > 20 years) who had been members of Kaiser Permanente, Northern California, for at least 4 months on December 31, 2001 (n = 2.1 million). Criteria from the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of Hypertension, the Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, and the Northern California Kaiser Permanente Diabetes Registry were applied to computerized databases for an 18-month period to identify HT, DL, and DM, respectively. Because screening for these conditions is incomplete, we applied age- and sex-specific prevalence estimates from the Third National Health and Nutrition Examination Survey to simulate full ascertainment.

Results: Unadjusted prevalence rates of HT, DL, and DM were 23.8%, 17.6%, and 6.6 %, respectively. More than 50% of persons with either HT or DL also had at least 1 other condition. Of all persons with DM, 74% had HT, 73% had DL, and 56% had both. Under full ascertainment, prevalence increased to 27.6%, 35.6%, and 8.7% for HT, DL, and DM, respectively, and co-occurrence increased further.

Conclusion: HT, DL, and DM co-occur in most affected individuals. To avoid fragmentation of care, disease management strategies should aim to manage these conditions within the same programs.

(Am J Manag Care. 2004;10(part 2):163-170)

Clinical trials have established that behavioral and pharmacologic therapy for lowering blood pressure, low-density lipoprotein cholesterol (LDL-C) levels, and glycemia in diabetes can markedly lower risk of cardiovascular disease, including both coronary heart disease (CHD) and stroke.[1-8] In the case of diabetes, the benefits of improving glycemic control may predominantly affect rates of microvascular complications rather than cardiovascular disease (CVD), but there is evidence that at least some hypoglycemic regimens also may lower risk of CVD.[8] Moreover, lowering LDL-C and blood pressure has proven to be particularly beneficial in diabetes patients, in part because of their greatly elevated baseline risk of CVD.[9-13]

These 3 conditions co-occur. Hypertension is common in persons with diabetes.[14] Associations between hypertension or diabetes and elevated LDL-C are less consistent,[15,16] but other lipid abnormalities—including decreased high-density lipoprotein cholesterol (HDL-C), increased plasma triglycerides, and increased levels of small, dense, LDL-C particles—frequently accompany both hypertension and glucose intolerance in diabetes and in the metabolic syndrome.[17,18] Because of the increased risk of CVD, the most recent revision of the National Cholesterol Education Program guidelines (Adult Treatment Panel 3 [ATP 3]) recommends more aggressive management of both hypertension and lipid abnormalities when they co-occur, or in the presence of diabetes.[19]

Population-based approaches to disease and risk factor management have appeared within organized healthcare systems in recent years.[20,21] However, if the extent of co-occurrence of these 3 conditions is high, disease management programs that manage all 3 conditions simultaneously may be more effective and efficient than programs targeted at single conditions.

Until recently, estimating the prevalence and overlap of hypertension with other conditions in clinical populations has been difficult because of a lack of computerized data for identifying hypertension. Whereas computerized laboratory and pharmacy data have been used for several years to identify diabetes and LDL-C levels in large healthcare systems, outpatient blood

From the Division of Research, Kaiser Permanente Medical Care Program, Northern California, Oakland, Calif (JVS, TP, AJK, MA, SS); and Pfizer, Inc, New York, NY (JL, AA, DP).

This research was funded by a grant from Pfizer, Inc.

Address correspondence to: Joe V. Selby MD MPH, Division of Research, 2000 Broadway, Oakland, CA 94612.

pressure readings have been much less widely available. Moreover, unlike the medications used to treat diabetes and LDL-C abnormalities, those used for hypertension are not unique to the condition and therefore do not identify the condition simply by their presence. These data deficiencies may have contributed to a lower level of attention to hypertension in disease management and quality improvement efforts.

In this study, we used newly available computerized data on outpatient blood pressure levels, along with computerized laboratory results, outpatient diagnoses, and prescriptions, to estimate the prevalence and overlap of these 3 conditions in a very large managed care population. Because screening for diabetes and elevated LDL-C levels is not uniformly practiced by clinicians, these 2 conditions are not fully ascertained in clinical databases. We therefore used data from the Third National Health and Nutrition Examination Survey (NHANES 3) to estimate what prevalence and co-occurrence of the 3 conditions would be if each were fully ascertained.

METHODS

Description of the Population

This study included the entire adult membership (age 20 years and above) of the Kaiser Permanente (KP) Medical Care Program, Northern California, as of December 31, 2001, who had been continuously enrolled for at least the prior 4 months. Kaiser Permanente is a fully integrated healthcare system that provided comprehensive medical care to just over 3 million members in northern California in 2001. Computerized clinical databases, including outpatient blood pressure measurements, diagnoses, laboratory results, and prescriptions, as well as hospital discharge databases, were searched for the prior 18 months to identify cases and to estimate the 18-month period prevalence of hypertension, dyslipidemia (elevated LDL-C), and diabetes mellitus. The rationale for the 18-month ascertainment window was that outpatient blood pressure measures have only been available for this period.

Diagnostic Criteria

The diagnostic criteria for each condition are provided in **Table 1.** All criteria were applied to computerized clinical data. For each condition, criteria depended in part on outpatient diagnoses and prescription records. However, hypertension and LDL-C elevations also could be identified without a diagnosis or prescription, based solely on laboratory or outpatient blood pressure results. Persons who met criteria for either of these conditions, but who did not have a compatible diagnosis or an appropriate prescription during the 18-month period, were classified as "undiagnosed" by a clinician. No comparable "undiagnosed" category was specified for diabetes because of the lack of a suitably diagnostic laboratory result. Glycosylated hemoglobin (HbA_{1c}) was used only rarely as a screening test. Screening fasting glucose requires repetition to confirm, which would be unlikely unless the diagnosis was strongly suspected (and therefore recorded). For hypertension and LDL-C, we used the risk-level specific blood pressure and LDL-C cut points specified by The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 6)[22] and ATP 3,[19] respectively. Hospital discharge diagnoses, outpatient diagnoses recorded at any time during the past 5 years, and laboratory data (serum creatinine values) were used to identify risk factors (eg, CHD, target organ disease) that lead to lower cut points for these 2 conditions.

Each of these clinical data sources has been shown to be highly accurate in validations against medical record review. The prescription and laboratory result databases are archived directly from electronic medical records and are therefore the official clinical records of each. The accuracy of the inpatient and outpatient diagnosis databases has been documented for several diagnoses.[23-25] Since mid-2000, the optically scanned encounter forms used in all of KP's outpatient clinics have allowed entry of a blood pressure recording in 8 preset categories for both systolic and diastolic pressure. These categories allow distinction of values above and below all key cut points shown in Table 1. In most clinics, blood pressure is initially measured by a medical assistant and entered onto the paper medical record. Clinicians review these entries, may repeat the measurement, and then enter either the recorded value or the value obtained at repeat measurement onto the encounter form. The accuracy of these computerized readings was examined in a study conducted by KP's Department of Quality and Utilization after the first year of blood pressure data entry (with more than 2.8 million blood pressure measurements entered). In 95% of 522 cases reviewed, the blood pressure category in the computerized database matched a blood pressure recorded in the medical chart at the same visit for both systolic and diastolic pressure. Some of the apparent discrepancies almost certainly reflect clinician failure to record the remeasured blood pressure in the paper record as well as true errors on the encounter form.

Estimating Prevalence and Overlap Using Clinical Data and Under Full Ascertainment

Age- and sex-specific prevalence of each condition was identified from the clinical data described above.

The co-occurrence (joint prevalence) of each pair of conditions and of all 3 conditions was also determined. Venn diagrams were used to allow visual examination of the overlap.

To examine changes in prevalence and overlap that might occur if 100% of the population had been screened for each condition, we obtained NHANES 3 data from the National Center for Health Statistics, Centers for Disease Control and Prevention.[26] Sex- and age-specific (10-year intervals) prevalences of hypertension, elevated LDL-C, and diabetes mellitus were calculated, along with joint prevalence, using the same risk-specific diagnostic criteria used for KP data (Table 1). Direct measurements of LDL-C, blood pressure, HbA_{1c}, and fasting glucose were available for 100% of the sample. To diagnose diabetes, either a HbA_{1c} value of ≥7% or a fasting glucose concentration of ≥126 mg/dL was used. These measurements were supplemented with self-report by subjects of current use of antihypertensive, lipid-lowering, and antidiabetic medications. Ascertainment of the comorbid conditions required to identify appropriate risk factor cut points for hypertension and LDL-C was based on self-report in the NHANES sample. These age- and sex-specific prevalence estimates for the NHANES sample were then applied to the age and sex distribution of the KP adult membership.

Table 1. Diagnostic Criteria for Diabetes Mellitus, Hypertension, and Dyslipidemia*

Diabetes Mellitus ***(1 of the following):***

- At least 1 prescription of insulin or an oral hypoglycemic agent; **or**
- At least 2 outpatient diagnoses of diabetes mellitus; **or**
- 1 outpatient diagnosis of diabetes mellitus plus ≥1 HbA_{1c} measurement of ≥7%; **or**
- At least 1 hospital discharge with a primary diabetes mellitus–related diagnosis (*ICD-9* code 250.X).

Hypertension ***(1 of the following):***

- At least 1 prescription for an antihypertensive medication plus an outpatient diagnosis of hypertension; **or**
- At least 2 outpatient diagnoses of hypertension; **or**
- At least 1 prescription for an antihypertensive medication plus 1 or more elevated outpatient blood pressure readings (≥140 mm Hg systolic, or ≥90 mm Hg diastolic†); **or**
- At least 1 outpatient diagnosis of hypertension plus at least 1 blood pressure reading of ≥140 mm Hg systolic or ≥90 mm Hg diastolic†; **or**
- At least 2 outpatient blood pressure readings of ≥140 mm Hg systolic, or ≥90 mm Hg diastolic†;

Dyslipidemia ***(1 of the following):***

- At least 1 prescription for an antilipemic agent; **or**
- LDL-C level equal to or above the risk-appropriate cut point value‡ on any measurement; **or**
- Outpatient diagnosis of dyslipidemia with a prior LDL-C value equal to or above the risk-appropriate cut point value‡ (within 2 years prior to July 1, 2000).

*HbA_{1c} indicates glycosylated hemoglobin; *ICD-9, International Classification of Diseases, Ninth Revision;* LDL-C, low-density lipoprotein cholesterol.
†For persons with diabetes mellitus or with diagnoses consistent with target organ disease (coronary heart disease, other heart disease, stroke/transient ischemic attack, nephropathy, peripheral vascular disease, or retinopathy), blood pressure cut points are lowered to ≥130 mm Hg systolic and ≥85 mm Hg diastolic.
‡Risk-appropriate cut point values for LDL-C are the following:

- **100 mg/dL:** For patients with known coronary heart disease or diabetes mellitus, or with ≥2 of the following risk factors: age ≥45 years for men, age ≥55 years for women, hypertension, HDL-C < 40 mg/dL, current cigarette smoking, and 10-year risk of coronary heart disease (by Framingham model) ≥ 20%;
- **130 mg/dL:** for other patients with ≥2 of the above risk factors;
- **160 mg/dL:** for all other patients.

RESULTS

Table 2 compares demographic and clinical characteristics of the KP population and the NHANES sample. The prevalences of diabetes, hypertension, and LDL-C elevations were, as expected, higher in the NHANES cohort because the entire population was evaluated for each condition. The prevalence of most comorbid conditions was quite similar for the KP population and the NHANES sample.

Table 2. Demographics and Prevalence of Key Comorbidities, Kaiser Permanente and NHANES 3 Populations*

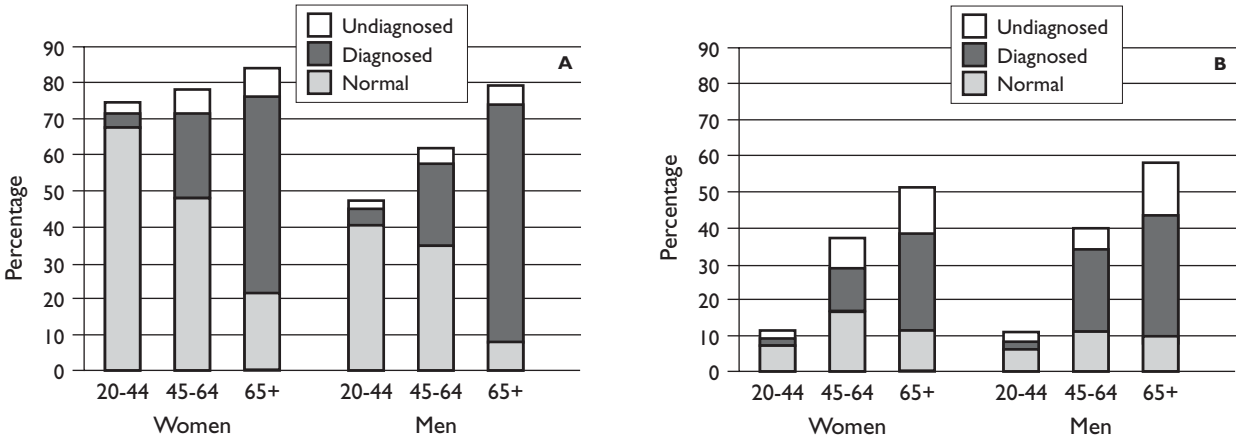
Characteristic	Kaiser Permanente			NHANES 3		
	Dyslipidemia	Hypertension	Hypertension + Dyslipidemia	Dyslipidemia	Hypertension	Hypertension + Dyslipidemia
	Nondiabetic Patients (n = 1 936 115)			Nondiabetic Patients (n = 7267)		
Number (% of Total)	112 116 (5.4)	238 943 (11.5)	154 246 (7.4)	1079 (13.6)	857 (10.8)	1031 (13.0)
Mean age, y	56.0 (0.04)	58.5 (0.03)	64.6 (0.03)	48.1 (0.56)	57.82 (0.80)	62.1 (0.73)
Female, %†	41.6 (0.15)	62.4 (0.10)	49.5 (0.13)	42.3 (2)	59.0 (3)	46.3 (2)
Coronary heart disease, %‡	11.0 (0.09)	4.7 (0.04)	26.6 (0.11)	12.8 (2)	5.2 (1)	18.7 (2)
Congestive heart failure, %	1.8 (0.04)	4.0 (0.04)	6.6 (0.06)	1.9 (1)	3.4 (1)	7.8 (2)
Stroke, %	1.9 (0.04)	4.0 (0.04)	7.4 (0.07)	1.6 (0)	2.9 (0)	6.3 (1)
Nephropathy and/or retinopathy, %§	1.7 (0.04)	5.8 (0.05)	8.7 (0.07)	3.3 (1)	5.4 (1)	8.5 (1)
	Diabetic Patients (n = 137 745)			Diabetic Patients (n = 692)		
Number (% of total)	21 778 (1.1)	24 104 (1.2)	76 826 (3.7)	187 (2.3)	162 (2.0)	539 (6.7)
Mean age, y	56.5 (0.09)	60.8 (0.09)	62.9 (0.04)	53.59 (1.32)	62.40 (1.29)	64.16 (0.88)
Female, %†	38.1 (0.33)	50.6 (0.32)	48.7 (0.18)	47.0 (7)	44.4 (4)	52.5 (3)
Coronary heart disease, %‡	12.8 (0.23)	11.0 (0.20)	26.6 (0.16)	4.8 (2)	13.2 (4)	18.5 (2)
Congestive heart failure, %	4.8 (0.14)	10.0 (0.19)	11.7 (0.12)	5.9 (2)	7.3 (2)	10.9 (2)
Stroke, %	3.7 (0.13)	7.3 (0.17)	9.6 (0.11)	4.4 (2)	6.0 (2)	9.4 (2)
Nephropathy and/or retinopathy,%§	8.0 (0.18)	19.5 (0.26)	24.7 (0.16)	13.0 (4)	28.8 (5)	19.7 (2)

*NHANES 3 indicates the Third National Health and Nutrition Examination Survey. Values in parentheses are standard errors of the mean.
†A total of 361individuals with inconsistent automated data on sex were excluded from this calculation.
‡Defined as history of myocardial infarction or angina.
§Kaiser Permanente data include only evidence of diabetic renal disease; NHANES 3 data include self-reports of either diabetic renal disease or kidney disease.

Frequency of Evaluation for Hypertension and Elevated LDL-C

Not surprisingly, evaluation for both hypertension and elevated LDL-C was much more common at older ages (**Figures 1A, 1B**) in the KP population. At all ages, evaluation was more frequent for hypertension than for LDL-C. Recorded blood pressure values were more frequent for women than for men, particularly at younger ages, presumably because women are more likely to have outpatient visits than men. A check of utilization data for the 18-month window revealed that 29.6% of men, but only 12.9% of women, in the 20- to 44-year-old age stratum had no outpatient visits during the 18-month window. These proportions decreased to only 6.9% of men and 5.9% of women in the 65+ year age group. Undiagnosed hypertension (ie, elevated values

Figure 1. Proportions of Adult Members Evaluated for, Diagnosed With, and Meeting Criteria but Without Evidence of a Diagnosis for (A) Hypertension and (B) Dyslipidemia, by Age and Sex



with no outpatient diagnosis of hypertension and no evidence of prescription of antihypertensive medications) was infrequent at all ages in terms of absolute prevalence. As a proportion of all hypertension identified, lack of a diagnosis or pharmacotherapy was more frequent in persons younger than age 45 years. In terms of both absolute prevalence and as a proportion of all LDL-C elevations identified, LDL-C elevations were more likely to be undiagnosed at all ages.

Prevalence and Overlap of the 3 Conditions

The prevalence of each condition increased markedly with age, as did the clustering or co-occurrence of 2 or all 3 conditions (**Table 3**). The prevalence of having all 3 conditions showed the strongest positive association with age. Hypertension was noted more frequently in women than men at all ages, whereas the prevalence of diabetes and LDL-C elevations was modestly greater for men. Isolated diabetes mellitus was uncommon at all ages. Even in the youngest group of adults, where the prevalence of hypertension and elevated LDL-C was relatively low, more than two thirds of both men and women with diabetes had at least 1 of the other 2 conditions. This proportion approached 90% for those age 45 to 64 years, and 95% for those age 65 years and above.

The overlap of the 3 conditions in clinical data for the entire adult population was striking (**Figure 2A**). More than half of the patients with either hypertension or elevations of LDL-C also had the other condition, and 3.7% of all adult patients had all 3 conditions. Isolated hypertension was more common than isolated elevation of LDL-C, because ascertainment for blood pressure was greater than that for LDL-C levels. Findings changed somewhat under conditions of full ascertainment, as simulated with NHANES 3 data. Prevalence of elevated LDL-C more than doubled, reflecting the relatively low rates of testing found in the clinical data, and isolated elevations of LDL-C became more common, accounting for 47% of all dyslipidemia. However, identifying more dyslipidemia actually reduced the prevalence of isolated hypertension and diabetes, despite somewhat increased detection of each of these conditions overall. Comparison of the two Venn diagrams suggests that even with full ascertainment, these 3 common conditions overlap in adult populations.

DISCUSSION

Whether based on clinically available data (which somewhat underestimate prevalence) or on full ascertainment using NHANES 3 data, diabetes mellitus, hypertension, and elevations of LDL-C co-occur at levels much greater than would be predicted solely on the basis of their prevalence. Explaining these associations is beyond the scope of the present paper, but substantial evidence points to obesity and insulin resistance as factors tightly linked to these conditions.[27,28] From the disease management perspective, 2 important messages emerge. First, identification of any 1 of these conditions should trigger a search for the other 2 conditions. Second, programs aimed at managing any 1 of these conditions should be prepared to evaluate and manage all 3 conditions. A multifactorial program targeting all 3 risk factors in persons with type 2 diabetes has recently been shown to dramatically lower the incidence of cardiovascular disease and other complications of diabetes.[29]

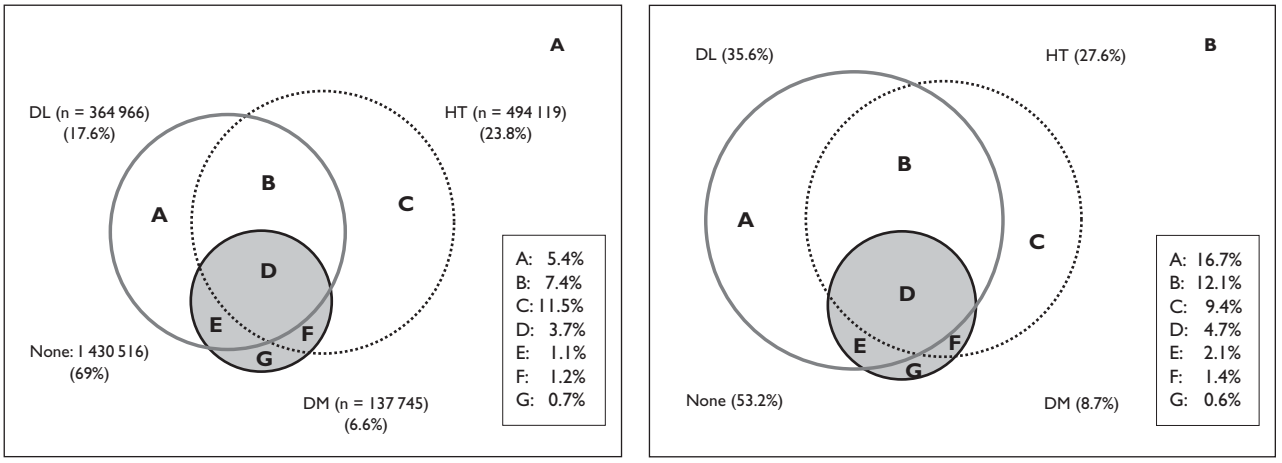
The remarkable overlap of diabetes mellitus with each of the other conditions deserves comment. More

Table 3. Prevalence and Co-occurrence of Hypertension, Dyslipidemia, and Diabetes, by Sex and Age*

	Total Prevalence of Each Condition, %			Prevalence of Combined Conditions, %				
Patient Age, y	HT	DL	DM	HT + DL	HT + DM	DL + DM	All 3 Conditions	None
				Females (n = 1 086 815)				
20-44	6.79	2.75	1.49	0.56	0.31	0.32	0.46	91.08
45-54	23.50	13.23	5.77	3.99	1.17	0.99	2.93	69.51
55-64	39.74	29.51	10.10	13.13	1.83	1.28	6.30	49.50
65+	62.25	38.96	13.63	21.86	2.52	1.20	9.21	29.16
All ages	25.32	15.52	5.87	7.03	1.12	0.76	3.44	69.07
				Males (n = 986 684)				
20-44	6.66	4.76	1.97	1.08	0.33	0.49	0.58	89.66
45-54	20.57	21.35	7.62	6.63	1.24	1.73	3.44	66.93
55-64	36.32	37.08	13.53	14.61	1.96	2.53	7.76	47.67
65+	57.47	47.05	18.07	23.64	3.07	2.41	11.40	29.33
All ages	22.18	19.88	7.49	7.89	1.21	1.37	3.99	68.90

*DM indicates diabetes; DL, dyslipidemia; and HT, hypertension.

Figur 2. Estimated Prevalence and Co-Occurrence of Hypertension (HT), Dyslipidemia (DL), and Diabetes Mellitus (DM) In 2.1 Million Adult Kaiser Permanente Members



Estimates were based on (A) available automated clinical data and (B) application of age- and sex-specific prevalence estimates for each condition from the Third National Health and Nutrition Examination Survey data to the Kaiser Permanente membership to simulate full ascertainment.

than 90% of all women and approximately 88% of all men with diabetes also met criteria for at least 1 of the other 2 conditions; 56% of all patients with diabetes had all 3 conditions. Neither of 2 possible artifactual explanations appear to account for most of this overlap. Lower cut points were used to diagnose both hypertension and dyslipidemia in the presence of diabetes, making the co-occurrence of both conditions with diabetes somewhat more likely. However, when we redefined hypertension and LDL-C elevation in diabetes patients with the same cut points used for nondiabetic patients, 83% of both men and women with diabetes still had at

least 1 other condition, and 46% of each sex had both. A second possible explanation is the increased tendency of physicians to screen for and diagnose hypertension and LDL-C in the presence of diabetes (surveillance bias). However, when we used NHANES 3 data to simulate full ascertainment, the overlap was even greater, primarily because much more dyslipidemia is found when everyone is screened. Thus, even if screening for diabetes increases dramatically, we should not expect to uncover many patients with isolated diabetes.

The overlap of dyslipidemia with both hypertension and diabetes was particularly striking in light of our definition, which focused solely on elevations of LDL-C. Reduction of LDL-C remains the primary aim of ATP 3 guidelines[19] and also has been the exclusive lipid focus of most disease management programs. However, ATP 3 also extends attention to abnormalities of plasma triglycerides and HDL-C. If these abnormalities (fasting triglycerides of ≥200 mg/dL, reductions in HDL-C to <40 mg/dL, or both) had been included in our definition, 94 322 additional persons would be identified, and the population prevalence of dyslipidemia would increase from 17.6% to 22.1%. Because these 2 abnormalities are typical of the metabolic syndrome,[17,18] which is strongly associated with both hypertension and type 2 diabetes, overlap of dyslipidemia with these conditions would increase further if the definition of dyslipidemia were expanded.

Our study is among the first to use outpatient blood pressure readings as well as clinical diagnoses to identify hypertension in a clinical population. This approach, more typical of epidemiologic than clinical studies, may slightly overestimate both prevalence and underdiagnosis (ie, high readings without a recorded diagnosis) of hypertension by including some patients who also had several normal blood pressure measurements during the 18 months in addition to the required 2 elevated readings. Nevertheless, our findings do suggest the likelihood that small proportions of patients meeting clinical criteria for hypertension remain undiagnosed and untreated.

The apparently low level of screening for lipids, especially in younger persons, is exaggerated by the methods used in this study. Most clinical guidelines call for screening every 5 years after initial normal values in the absence of diabetes or coronary heart disease. To maintain consistency with our ascertainment approach for hypertension and diabetes, we sought lipid measurements for only an 18-month period. This approach would count as "unscreened" many lower risk individuals who had had normal results within the prior 3.5 years, and for whom screening was indicated during this interval. The extraordinary prevalence of elevated LDL-C under full ascertainment emphasizes the importance of periodic screening.

Elevations of LDL-C were more likely than hypertension to be undiagnosed at all ages. However, we used the new cut points of the ATP 3 for diagnosing elevated LDL-C. These lower cut points, particularly for persons with diabetes or other CHD risk equivalents (cut point of ≥100 mg/dL) and for other persons with 2 or more CHD risk factors (cut point of ≥130 mg/dL), were first promulgated in May 2001, halfway through our study period. Thus, it may overstate the case to label these persons as "undiagnosed." The large impact of changes in these cut points on the numbers of persons eligible for treatment has been documented.[30] Dissemination of this information into clinical practice would not be expected to be complete in this narrow time frame. Further, for many of these persons, pharmacotherapy is not necessarily indicated,[19] and clinicians may be somewhat less likely to note a diagnosis when pharmacotherapy is not contemplated. Nevertheless, others have previously found that elevations of LDL-C are more likely to be overlooked and untreated than hypertension or hyperglycemia, even among persons with diabetes.[31]

Prevalence estimates for each condition may be slightly low because we included persons who had been members for as short a time as the last 4 months of the 18-month window. Thus, small numbers of persons with 1 or more conditions may not have been members long enough to generate diagnostic, prescription, or laboratory data to identify their conditions. Recalculation of prevalence estimates in persons who were continuously enrolled for the full 18 months reduced the population size by approximately 15% and increased the prevalence of hypertension from 23.8% to 26.2%, of dyslipidemia from 17.6% to 19.3%, and of diabetes from 6.6% to 7.3%.

Finally, some differences in prevalence between the KP population and the NHANES sample could be due to differences in the distribution of race/ethnicity of the 2 groups, or to the fact that the entire KP population resides in northern California, whereas NHANES is a national sample. The NHANES sample was 10.6% African American and 8.9% Hispanic/Latino. Complete race/ethnicity information for the KP membership is not available, but a large survey of 30 000 adult members in 1999 suggested that the KP membership age 20 years and above is approximately 64% white, 7% African American, 12% Hispanic/Latino, and 16% Asian/Pacific Islander.

In conclusion, our data confirm that all 3 of these conditions should be considered and managed together

as part of both primary and secondary CVD prevention efforts. As computerized blood pressure data become more available to healthcare systems, improved population approaches to supporting the management of these associated conditions can be implemented.

REFERENCES

1. Hypertension Detection and Follow-up Program Cooperative Group. Five-year findings of the hypertension detection and follow-up program. I. Reduction in mortality of persons with high blood pressure, including mild hypertension. *JAMA.* 1979;242:2562-2571.

2. Systolic Hypertension in the Elderly Program Cooperative Research Group. Prevention of stroke by antihypertensive drug treatment in older persons with isolated systolic hypertension. *JAMA.* 1991;265:3255-3264.

3. The Lipid Research Clinics Coronary Primary Prevention Trial results. I. Reduction in incidence of coronary heart disease. *JAMA.* 1984;251:351-364.

4. Frick MH, Elo O, Haapa K, et al. Helsinki Heart Study: primary-prevention trial with gemfibrozil in middle-aged men with dyslipidemia. Safety of treatment, changes in risk factors, and incidence of coronary heart disease. *N Engl J Med.* 1987;317:1237-1245.

5. Randomised trial of cholesterol lowering in 4444 patients with coronary heart disease: the Scandinavian Simvastatin Survival Study (4S). *Lancet.* 1994;344:1383-1389.

6. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med.* 1993;329(14):977-986.

7. UK Prospective Diabetes Study Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet.* 1998;352:837-853.

8. UK Prospective Diabetes Study Group. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). *Lancet.* 1998;352:854-865.

9. UK Prospective Diabetes Study Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *BMJ.* 1998;317:703-713.

10. Curb JD, Pressel SL, Cutler JA, et al. Effect of diuretic-based antihypertensive treatment on cardiovascular disease risk in older diabetic patients with isolated systolic hypertension. *JAMA.* 1996;276:1886-1892.

11. Koskinen P, Manttari M, Manninen V, Huttunen JK, Heinonen OP, Frick MH. Coronary heart disease incidence in NIDDM patients in The Helsinki Heart Study. *Diabetes Care.* 1992;15:820-825.

12. Pyorala K, Pedersen TR, Kjekshus J, et al. Cholesterol lowering with simvastatin improves prognosis of diabetic patients with coronary heart disease. *Diabetes Care.* 1997;20:614-620.

13. Goldberg RB, Mellies MJ, Sacks FM, et al. Cardiovascular events and their reduction with pravastatin in diabetic and glucose-intolerant myocardial infarction survivors with average cholesterol levels: subgroup analyses in the Cholesterol and Recurrent Events (CARE) trial. *Circulation.* 1998;98:2513-2519.

14. ADA Consensus Panel. Role of cardiovascular risk factors in prevention and treatment of macrovascular disease in diabetes. *Diabetes Care.* 1993;12:573-579.

15. Laakso M, Lehto S, Penttila I, Pyorala K. Lipids and lipoproteins predicting coronary heart disease mortality and morbidity in patients with non-insulin-dependent diabetes. *Circulation.* 1993;88:1421-1430.

16. Goldschmid MG, Barrett-Connor E, Edelstein SL, Wingard DL, Cohn BA, Herman WH. Dyslipidemia and ischemic heart disease mortality among men and women with diabetes. *Circulation.* 1994;89:991-997.

17. Haffner SM. Management of dyslipidemia in adults with diabetes. *Diabetes Care.* 1998;21:160-178.

18. Meigs JB. Epidemiology of the metabolic syndrome, 2002. *Am J Manag Care.* 2002;8(11 suppl):S283-292.

19. Executive Summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA.* 2001;285(19):2486-2497.

20. Epstein RS, Sherwood LM. From outcomes research to disease management: a guide for the perplexed. *Ann Intern Med.* 1996;124:832-837.

21. Ellrodt G, Cook DJ, Lee J, Cho M, Hunt D, Weingarten S. Evidence-based disease management. *JAMA.* 1997;278:1687-1692.

22. Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure. The sixth report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI). *Arch Intern Med.* 1997;157:2413-2446.

23. Levin TR, Schmittdiel JA, Kunz K, et al. Costs of acid-related disorders to a health maintenance organization. *Am J Med.* 1997;103:520-528.

24. Go AS, Hylek EM, Borowsky LH, Phillips KA, Selby JV, Singer DE. Warfarin use among ambulatory patients with nonvalvular atrial fibrillation: the Anticoagulation and Risk Factors in Atrial Fibrillation (ATRIA) study. *Ann Intern Med.* 1999;131:927-934.

25. Karter AJ, Ferrara A, Liu JY, Moffet HH, Ackerson LM, Selby JV. Ethnic disparities in diabetic complications in an insured population. *JAMA.* 2002;287:2519-2527.

26. National Center for Health Statistics. National Health and Nutrition Examination Survey. Available at: http://www.cdc.gov/nchs/nhanes.htm. Accessed August 2002.

27. Reaven GM. 1988 Banting Lecture: role of insulin resistance in human disease. *Diabetes.* 1988;37:1595-1607.

28. Despres J-P, Lamarche B, Mauriege P, et al. Hyperinsulinemia as an independent risk factor for ischemic heart disease. *N Engl J Med.* 1996;334:952-957.

29. Gaede P, Vedel P, Larsen N, Jensen GVH, Parving H-H, Pedersen O. Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *N Engl J Med.* 2003;348:383-393.

30. Fedder DO, Doro CE, L'Italien GJ. New National Cholesterol Education Program III guidelines for primary prevention lipid-lowering drug therapy: projected impact on the size, sex, and age distribution of the treatment-eligible population. *Circulation.* 2002;105:152-156.

31. Grant RW, Cagliero E, Murphy-Sheehy P, Singer DE, Nathan DM, Meigs JB. Comparison of hyperglycemia, hypertension, and hypercholesterolemia management in patients with type 2 diabetes. *Am J Med.* 2002;112:603-609.