Prevalence of Comorbid Hypertension and Dyslipidemia and Associated Cardiovascular Disease

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Objectives: To estimate the prevalence of concurrent hypertension and dyslipidemia among a general veteran population and separately among patients with diabetes mellitus, and to compare the prevalence of cardiovascular disease among groups with isolated versus concurrent hypertension and dyslipidemia.

Study Design: Retrospective cohort study.

Patients and Methods: This study was conducted in 6 medical centers of the Department of Veterans Affairs and included 371 221 patients seen for any reason from October 1, 1998, to September 30, 2001. The proportion of patients with isolated or concurrent hypertension and dyslipidemia was estimated based on diagnostic, pharmacy, laboratory, and vital sign information, and the age-adjusted proportions of individuals with cardiovascular disease were compared between groups.

Results: We found that 57.8% of all patients had hypertension or dyslipidemia; 30.7% had both. Sixteen percent of all patients had diabetes mellitus, and 66.3% of these patients had concomitant hypertension and dyslipidemia. The prevalence of coronary artery disease was often more than doubled among patients with concomitant conditions compared with patients with either condition alone. The prevalence of stroke and peripheral arterial disease similarly increased among patients with both conditions. The prevalence of these cardiovascular diseases was highest among patients with diabetes mellitus.

Conclusion: The prevalence of cardiovascular disease was high among this population of older, predominately male US veterans.

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Cardiovascular disease (CVD) is estimated to affect more than 64 million individuals in the United States. Furthermore, CVD is the leading cause of death in the United States, resulting in approximately 38.5% of all deaths, or about 931 000 deaths per year, and contributing to more than $368 billion in annual economic costs.[1] Abnormalities in plasma lipoprotein metabolism play a central role in the pathogenesis of atherosclerosis, and arterial hypertension with elevated systolic or diastolic blood pressure (BP) is positively and independently associated with coronary heart disease (CHD).[2,3]

Data from the Framingham Study demonstrated that hypertension tends to occur in association with other atherogenic risk factors (eg, 78% of hypertensive men and 82% of hypertensive women had multiple cardiovascular [CV] risk factors).[4] Patients with multiple CV risk factors are at much greater risk for CVD events than those with 1 risk factor. Indeed, the risk of CVD associated with the presence of concomitant hypertension and dyslipidemia is typically greater than the sum of the CVD risks for hypertension and dyslipidemia alone.[5] This has been recognized in recent treatment guidelines that emphasize the need to quantify a person's overall CVD risk.[6,7]

This study was undertaken to estimate the prevalence of hypertension, dyslipidemia, or both conditions among a large region of the Department of Veterans Affairs (VA) healthcare system. We also examined the prevalence of these conditions among patients with and without diabetes mellitus. We hypothesized that the proportion of patients with CVD morbidities would be much greater in patients with concomitant hypertension and dyslipidemia compared with patients with isolated hypertension or dyslipidemia. The study was conducted to assist resource allocation and the provision of effective disease management programs in the VA.

METHODS

Study Design

A retrospective design was used to collect data longitudinally during 3 years. The prevalence of hypertension, dyslipidemia, and diabetes mellitus was estimated by identifying the proportion of all individuals who

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had these conditions at any time during the study. Therefore, this period prevalence estimate combines prevalent and incident cases.

Data Sources

Computerized data from 6 VA acute care medical centers located in a regional network (Mississippi, Louisiana, Arkansas, Oklahoma, and Texas) were obtained from October 1, 1998, to September 30, 2001, corresponding to fiscal years 1999 to 2001. Three data sources were used: (1) diagnostic information in the form of *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes; (2) prescription drug dispensing from pharmacy dispensing records; and (3) clinical factors from laboratory test results and vital signs. All data were transferred over the VA intranet from the regional network data warehouse computer system to the study team for analysis. The study was authorized by the local institutional review boards and VA research review committees at each site.

Inclusion Criteria

All patients seen at these 6 hospitals and their affiliated outpatient clinics during the 3 years formed the denominator for this study (N = 371 221). Patients were identified for inclusion in the study based on a combination of the 3 sources of data. Hospital discharge abstracts and outpatient clinic visit records were searched to find diagnostic criteria. Pharmacy prescription records were searched for fill records from the drug classes indicated for treatment of any of the 3 conditions (hypertension, dyslipidemia, and diabetes mellitus). Laboratory test values and vital signs were searched for any low-density lipoprotein cholesterol (LDL-C), hemoglobin A_{1C} (HbA_{1C}), or BP values. Elevated BP was defined according to the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure[8] (130/85 mm Hg or 140/90 mm Hg depending on risk factors), and elevated LDL-C was defined according to the National Cholesterol Education Program (100 mg/dL, 130 mg/dL, or 160 mg/dL depending on risk factors). Elevated HbA_{1C} was defined as 6.5% or higher. The use of HbA_{1C} alone (> 6.2%) as a diagnostic criterion has been shown to improve the case identification of diabetes mellitus above the rates achieved by American Diabetes Association criteria, and patients with this level have been shown to be at increased CV risk.[9-13] This value is outside the normal range of HbA_{1C} among patients in the VA (normal range at the time of this study, 4.6%-6.5%), is useful as a screening tool in large populations to improve sensitivity among patients in whom the use of fasting glucose tests is impractical, and has been used previously within the VA.[14] Patients were then classified as having hypertension, dyslipidemia, or diabetes mellitus if they met specific criteria based on algorithms using all 3 sources of data.[15]

Patients were classified as having hypertension if they met any of the following 5 criteria: (1) at least 2 outpatient diagnoses of hypertension, (2) at least 1 prescription of an antihypertensive drug plus at least 1 outpatient diagnosis of hypertension, (3) at least 1 prescription of an antihypertensive drug plus at least 1 elevated BP measurement, (4) at least 1 elevated BP measurement plus 1 outpatient diagnosis of hypertension, or (5) at least 2 elevated BP measurements.

Patients were classified as having dyslipidemia if they met any of the following 3 criteria: (1) at least 2 outpatient diagnoses of dyslipidemia, (2) at least 1 prescription of an antilipemic drug, or (3) at least 1 elevated fasting LDL-C level.

Patients were classified as having diabetes mellitus if they met any of the following 4 criteria: (1) at least 2 outpatient diagnoses of diabetes mellitus, (2) at least 1 inpatient diagnosis of diabetes mellitus, or (3) at least 1 prescription of an antidiabetic drug or monitoring supply, or (4) at least 1 elevated HbA_{1C} level.

For example, the algorithm for diabetes mellitus identified patients by the presence of inpatient or outpatient *ICD-9-CM* diagnostic codes, by use of drugs to treat diabetes mellitus, or by ever reaching elevated HbA_{1C} values. Patients meeting any of the 3 criteria were thus classified as having diabetes mellitus. Patients with dyslipidemia were similarly identified based on outpatient *ICD-9-CM* codes, lipid-lowering drugs, or ever reaching elevated LDL-C levels. Patients with hypertension could be identified based on *ICD-9-CM* codes alone, but identification based on drugs or clinical factors required additional diagnostic information to improve specificity. For example, the use of any CV antihypertensive drug alone was not sufficient and required the presence of a diagnostic code or elevated BP reading, because antihypertensive drugs could also be prescribed for indications other than hypertension. Patients who met these criteria formed the numerators for disease groups. Complete algorithms with definitions of diagnostic, pharmacy, and clinical factors are available on request from the first author.

Demographic data (age and sex) and information on CVD comorbidities were similarly obtained from the inpatient and outpatient records. Comorbidity information included the following nonfatal CV events: prior myocardial infarction (MI), coronary artery disease (CAD), and other atherosclerosis, including peripheral arterial disease (PAD) and cerebrovascular disease (the coding of comorbidities is available on request from the

Table 1. Demographic Characteristics of Patients With Isolated or Concomitant Hypertension and Dyslipidemia Among 311 321 Nondiabetic Patients*

Characteristic	Hypertension Only	Dyslipidemia Only	Hypertension and Dyslipidemia	All Others (No Hypertension or Dyslipidemia)
	(n = 67 544 [21.7])†	(n = 17 838 [5.7])	(n = 74 106 [23.8])	(n = 151 833 [48.8])†
Age, y				
< 45	10 459 (15.5)	2954 (16.6)	4772 (6.4)	47 332 (31.2)
45-64	27 686 (41.0)	9404 (52.7)	33 201 (44.8)	55 780 (36.7)
65-74	14 582 (21.6)	3563 (20.0)	22 320 (30.1)	19 750 (13.0)
≥ 75	14 815 (21.9)	1917 (10.7)	13 813 (18.6)	28 971 (19.1)
Age, mean (SD)	60.2 (15.0)	56.5 (13.0)	62.6 (11.9)	53.2 (16.8)
Male sex	64 226 (95.1)	16 338 (91.6)	71 390 (96.3)	124 072 (81.7)

*Data are given as number (percentage) unless otherwise indicated.
†Age was missing in 2 patients.

first author). We do not report data on race or ethnicity, because this information is recorded as missing or unknown in up to 40% of cases for outpatients.

Data Analysis

The prevalence of isolated and concurrent hypertension and dyslipidemia is reported. Demographic information is presented for selected disease groups. We present age-adjusted proportions of patients with CV comorbidities among patients with hypertension alone, dyslipidemia alone, or both conditions for nondiabetic patients and separately for patients with diabetes mellitus. Age adjustment was performed by stratifying the samples into 4 age groups: younger than 45 years, 45 to 64 years, 65 to 74 years, and 75 years or older. The difference in proportions of patients with CV comorbidities was compared between the 3 groups (hypertension alone, dyslipidemia alone, or both conditions) and tested by the normal approximation to the binomial.

RESULTS

Overall Observed Prevalence

A total of 371 221 patients were seen in these VA medical centers during the 3 years. About 90% of these patients were male, and their mean age was 57.7 years. A total of 214 497 patients (57.8%) met the criteria for having hypertension or dyslipidemia, and 113 803 patients (30.7%) met criteria for having both conditions. Specifically, 52.1% of patients (n = 193 497) met the criteria for hypertension, 36.3% of patients (n = 134 803) met the criteria for dyslipidemia, and 16.1% of patients (n = 59 900) met the criteria for diabetes mellitus.

Prevalence and Demographic Information

For all subsequent analyses, we stratified the sample into 2 groups: nondiabetic patients and patients with diabetes mellitus. Among nondiabetic patients, 21.7% had hypertension without dyslipidemia, 5.7% had dyslipidemia without hypertension, 23.8% had both conditions, and 48.8% had neither. The mean age was 60.2 years for patients with hypertension only, 56.5 years for patients with dyslipidemia only, and 62.6 years for patients with concomitant hypertension and dyslipidemia (**Table 1**). Among patients with diabetes mellitus, rates of isolated conditions were similar to those of nondiabetic patients, but the rate of concomitant hypertension and dyslipidemia was 66.3% (**Table 2**), or more than double the proportion in nondiabetic patients.

Risk for Cardiovascular Outcomes in Disease Groups

The proportions of patients with CV comorbidities generally increased with age within each CV risk factor group (**Table 3**). Proportions of all CV comorbidities were statistically significantly higher ($P < .05$) in patients with concomitant hypertension and dyslipidemia compared with patients with isolated hypertension or dyslipidemia, except for the following 3 subgroups of patients with diabetes mellitus (those younger than 45 years with PAD, those younger than 45 years with cerebrovascular disease, and those 75 years or older with cerebrovascular disease). Among patients with both hypertension and dyslipidemia, the proportions of patients with MI were generally 2 to 3 times the prevalences among patients with isolated conditions. For example, in the group aged 45 to 64 years, 2.0% to 4.7% of patients with hypertension or dyslipidemia

Table 2. Demographic Characteristics of Patients With Isolated or Concomitant Hypertension and Dyslipidemia Among 59 900 Patients With Diabetes Mellitus*

Characteristic	Hypertension Only	Dyslipidemia Only	Hypertension and Dyslipidemia	All Others (No Hypertension or Dyslipidemia)
	(n = 12 150 [20.3])	(n = 3162 [5.3])	(n = 39 697 [66.3])	(n = 4891 [8.2])
Age, y				
< 45	630 (5.2)	263 (8.3)	1519 (3.8)	502 (10.3)
45-64	4425 (36.4)	1503 (47.5)	17 919 (45.1)	1985 (40.6)
65-74	3503 (28.8)	910 (28.8)	13 275 (33.4)	1318 (26.9)
≥ 75	3592 (29.6)	486 (15.4)	6984 (17.6)	1086 (22.2)
Age, mean (SD)	65.5 (12.5)	60.9 (12.1)	63.5 (10.8)	62.3 (13.8)
Male sex	11 827 (97.3)	3024 (95.6)	38 661 (97.4)	4642 (94.9)

*Data are given as number (percentage) unless otherwise indicated.

Table 3. Prevalence of Cardiovascular Comorbidities Among Patients With Isolated or Concomitant Hypertension and Dyslipidemia by Age*

	% of Nondiabetic Patients			% of Patients With Diabetes Mellitus		
Comorbidity and Age Group, y	Hypertension Only	Dyslipidemia Only	Hypertension and Dyslipidemia	Hypertension Only	Dyslipidemia Only	Hypertension and Dyslipidemia
	(n = 67 544)	(n = 17 838)	(n = 74 106)	(n = 12 150)	(n = 3162)	(n = 39 697)
Myocardial infarction						
< 45	0.6	1.0	4.8†	1.30	1.1	4.8†
45-64	2.0†	2.8†	9.3†	4.7‡	3.5	12.0†‡
65-74	3.3	3.2	9.1†	7.1†‡	3.3†	11.7†‡
≥ 75	4.0	4.4	9.3†	7.7†‡	4.3†	10.9†‡
Coronary artery disease						
< 45	8.5†	10.9†	19.7†	11.9†‡	5.3†‡	17.4†
45-64	11.7†	17.4†	28.0†	15.1‡	14.9	29.3†‡
65-74	18.8†	29.0†	40.3†	25.1‡	25.2	39.2†
≥ 75	25.0†	32.8†	45.8†	30.8†‡	24.1†‡	42.9†‡
Peripheral arterial disease						
< 45	0.7	0.5	2.5†	1.6	1.9	3.5
45-64	2.9	2.7	6.9†	6.4†‡	2.7†	10.7†‡
65-74	6.5	5.5	12.1†	12.2†‡	4.5†	15.9†‡
≥ 75	7.9†	6.3†	13.8†	13.6†‡	4.7†	16.2†‡
Cerebrovascular disease						
< 45	1.4	1.3	4.1†	2.7	1.5	4.1
45-64	4.0†	3.1†	9.6†	7.4†‡	3.3†	11.7†‡
65-74	8.8†	5.5†	14.3†	15.2†‡	7.0†	17.4†‡
≥ 75	13.1†	8.0†	19.2†	18.6†‡	10.7†	20.3†

*Column percentages for the 4 comorbidities are based on percentages of the column totals. Percentages for coronary artery disease exclude patients already counted with myocardial infarction.
†Proportions are statistically significantly different compared with the other groups, $P < .05$.
‡Proportions are statistically significantly different compared with the corresponding proportions among nondiabetic patients, $P < .05$.

alone had a history of MI, rising to 9.3% to 12.0% among patients with both conditions.

The proportions of patients with each CVD varied between patients with hypertension, dyslipidemia, or both conditions. In many cases, the proportions in each disease group were statistically significantly different from those in the other groups. For example, among nondiabetic patients, the prevalence of CAD was statistically significantly lowest for all age categories among the hypertension-only group compared with the dyslipidemia-only group or patients with both conditions. Furthermore, the prevalence of CAD for all age categories was statistically significantly highest among the concomitant hypertension and dyslipidemia group, compared with the dyslipidemia-only group. The prevalences of PAD and cerebrovascular disease were lowest among patients with dyslipidemia only (among patients with and without diabetes mellitus) and were about 2 to 3.5 times higher among patients with both conditions versus those with hypertension or dyslipidemia alone.

Among patients with diabetes mellitus, proportions marked in Table 3 with a double dagger were statistically significantly different (almost always higher) than the corresponding proportions among nondiabetic patients. For example, compared with nondiabetic patients, for almost all age groups, the prevalence of all CV comorbidities was much higher among patients with hypertension, implying that diabetes mellitus may confer an additive risk to the risk from hypertension alone. However, among patients with dyslipidemia and diabetes mellitus, the rates were not statistically significantly different (except for those younger than 45 years or 75 years or older with CAD), indicating that there may be no additional risk conferred by diabetes mellitus or that dyslipidemia and diabetes mellitus are collinear. All rates were highest among patients with diabetes mellitus and concomitant hypertension and dyslipidemia.

DISCUSSION

This study found that nearly one third (30.7%) of all patients had both hypertension and dyslipidemia. A substantial proportion (57.8%) of all patients seen at these VA medical centers during 3 years had hypertension or dyslipidemia. The overall prevalence of diabetes mellitus was 16.1%. Among patients with diabetes mellitus, almost two thirds (66.3%) of patients also had hypertension and dyslipidemia, which is more than twice the rate (23.8%) of concomitant hypertension and dyslipidemia observed in the nondiabetic population in this study; 86.6% of patients with diabetes mellitus also had hypertension and 71.6% also had dyslipidemia. These proportions were considerably higher than the rates of hypertension and dyslipidemia (45.5% and 29.5%, respectively) in the nondiabetic population. Therefore, 92% of patients with diabetes mellitus also had hypertension or dyslipidemia or both.

The prevalence of age-adjusted CV comorbidities (MI, CAD, PAD, and cerebrovascular disease) increased dramatically among patients with concomitant hypertension or dyslipidemia compared with patients with isolated conditions. The prevalence of all CV comorbidities was highest among patients with all 3 conditions.

We sought to place our findings in the context of other studies. Estimates from the National Health and Nutrition Examination Survey III found that the prevalence of hypertension was 32.8% and the proportion of patients with LDL-C above 130 mg/dL was 49% for men and 43% for women.[1] We found a 52.1% prevalence of hypertension and a 36.3% prevalence of dyslipidemia. The national estimate for the prevalence of diabetes mellitus was 7.3%, whereas we observed that 16.1% of VA patients had diabetes mellitus. Our findings were consistent with the hypothesis that VA patients tend to have a higher prevalence of chronic disease than non-VA populations and that VA patients bear a larger burden of disease relative to a non-VA sample.

Our observations have several important implications. First, they illustrate the severe burden of chronic comorbid conditions and associated CV risk among veterans. In a study by Wolff et al[16] of Medicare beneficiaries, nearly two thirds of older persons were found to have multiple chronic conditions, placing them at increased risk for costly avoidable hospitalizations and preventable complications. Nearly one third (30.7%) of all patients in our study had both hypertension and dyslipidemia. Applying this estimate to the entire VA system, some 2 million veterans currently seeking care would have both of these prevalent conditions. This would impose an enormous burden on the VA system overall and on individual providers in particular, for example, in providing complex medical management for multiple comorbid conditions during limited clinic visits. Patients with these 2 conditions were found to have 3 to 4 times the prevalence of MI than patients with either condition alone, and 2 to 3 times the prevalences of CAD, PAD, and cerebrovascular disease. Interestingly, rates of MI and CAD were also higher among nondiabetic patients with hypertension and dyslipidemia than among patients with hypertension and diabetes mellitus, implying that dyslipidemia may confer a greater risk than diabetes mellitus, even though diabetes mellitus is a risk equivalent to CHD. Finally, the finding that 92% of patients with diabetes mellitus also have hypertension or dyslipidemia or both is striking.

Recently, Snow et al[17] summarized clinical trial evidence emphasizing the need for tight BP control in patients with diabetes mellitus. A companion article by Vijan and Hayward[18] noted that more than 80% of patients with type 2 diabetes mellitus develop or die of macrovascular complications (CAD, cerebrovascular disease, or PAD). The authors questioned whether treatment efforts should focus on macrovascular control, rather than glucose control and microvascular complications. Clinicians need to be aware of the large proportion of patients who have both hypertension and dyslipidemia, as well as the large proportion of patients with diabetes mellitus who also have hypertension or dyslipidemia or both.

All 3 of the conditions examined are chronic and require comprehensive community-based and healthcare system disease management strategies, including medication, lifestyle modifications, and patient self-management. Recognizing that the first step in resource planning and treatment requires a practical way to identify patients and determine their comorbidities, we used a method based on existing computerized medical record information. Although clinical examination and laboratory testing are ideal for determining the presence of disease, it is cost prohibitive and impractical to undertake in a large national sample. Therefore, the use of a combination of diagnostic, pharmacy, laboratory, and vital sign data sources is a reasonable strategy to maximally identify the prevalence of disease among a large cohort.

Recent studies[19,20] have suggested that substantial reductions in the risk of CVD-related events can be achieved by targeting hypertension and dyslipidemia. For example, it has been calculated that 79% of ischemic heart disease events and 69% of strokes would be prevented if LDL-C levels were reduced by 70 mg/dL (1.8 mmol/L) and diastolic BP by 11 mm Hg.[19] Similarly, in patients with metabolic syndrome, control of LDL-C, high-density lipoprotein cholesterol, and BP to normal levels would result in preventing 51.3% of CHD events for men without CHD or diabetes mellitus and 42.6% for women; control to optimal levels would prevent 80.5% and 82.1%, respectively, of these events. Data supporting these calculations have been obtained from clinical trials, which have demonstrated that the intensive treatment of modifiable CV risk factors can markedly reduce the risk of CV events.[21,22] In addition, a recent study by Khot et al,[23] which showed that 80% to 90% of patients with CHD have conventional risk factors (smoking, hypertension, hyperlipidemia, and diabetes mellitus) in contrast to conventional thinking that more than half of such patients lack them, provides strong rationale for focusing on these conditions. The aggressive treatment of these common modifiable CV risk factors, particularly in patients at high risk for CV events such as those with concomitant hypertension and dyslipidemia or diabetes mellitus, could prevent some of the increased risk of MI and stroke in patients with multiple versus single CV risk factors observed in this study.

A possible concern of our study is that we determined a period prevalence estimate, which may be less desirable than obtaining a simple point prevalence estimate, or distinguishing the prevalence from the incidence rate. For example, our prevalence may be overestimated by inclusion of incident cases or may be considered unreliable if the population is unstable, the disease prevalence varies, or both. Because these are chronic conditions, the prevalence rate is not subject to the fluctuations that would occur in measuring an acute condition over time. Similarly, the population is not fixed but includes immigration and emigration; hence, it is a stable but dynamic cohort. In such cases, and when the exact onset of disease is difficult to determine as is the case with these conditions, it is preferable to estimate a period prevalence.[24]

A limitation is that our estimates of prevalence may be imprecise because of selection biases or operationalization of the clinical definitions by computerized medical records. For example, not all patients may be identified, because the diagnosis, pharmacy, and laboratory data capture only services provided by the VA system. The use of single measurements of LDL-C or HbA_{1C} might overestimate the prevalence of dyslipidemia and diabetes mellitus; this highlights the importance of using supplementary information from diagnostic and pharmacy sources in addition to the clinical factors. Conversely, patients who had their LDL-C or HbA_{1C} measured outside the VA system could not be identified based on their clinical factors alone. Patients may use non-VA pharmacies, resulting in underrepresentation in the pharmacy records. However, because veterans are often uninsured or underinsured[25] and the VA pharmacy copayment was only $2 per prescription during this study (increased to $7 per prescription in February 2002), underidentification from pharmacy records is less likely. Nonetheless, the inclusion of diagnostic, laboratory, and vital signs information further mitigates this concern. Therefore, the use of all 3 sources of information helps to balance limitations of relying on a single source of information. Finally, although not separately validated in this study, the algorithms to identify patients have been used in other managed care systems based on computerized data[15] and are not very different from algorithms used successfully in the VA. For example, the study by Miller et al[26] found that

a combination of prescription records for a diabetes medication or *ICD-9-CM* codes for diabetes mellitus had 93% sensitivity and 98% specificity against patient self-report.

Finally, the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure recently released the Seventh Report,[7] which lowered the target BP to 130/80 mm Hg (from 130/85 mm Hg) in patients with diabetes mellitus or chronic kidney disease. We determined it was appropriate to use the Sixth Report[8] levels that were current at the time of our study; however, our estimate of the prevalence of hypertension is therefore now a conservative one.

CONCLUSIONS

This study estimated the prevalence of 3 chronic conditions (hypertension, dyslipidemia, and diabetes mellitus) with significant CV risk and found them to be common among patients in the VA. In fact, the VA population bears a larger burden of CV conditions than non-VA populations. Identification of the burden of disease is essential for clinicians and managers to properly provide healthcare and manage resources. The prevalence of CVD increased dramatically among patients with more than 1 condition and appeared to increase more than additively. Further research is needed to quantitatively describe the increased risk of patients with multiple versus single CV conditions. Our study used a practical method to identify patients using existing computerized sources of information. Such a method also forms the basis for future work to describe treatment patterns and estimate attainment of treatment goals. In accord with recent therapeutic guidelines, our observations highlight the importance of diagnosing and treating all CV risk factors to reduce the development of CVD. The major policy implication of this research is that the accurate identification of the complete burden of disease, including the presence of multiple chronic conditions, is essential to provide healthcare systems with the necessary information for resource allocation and provision of comprehensive disease management.

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