ORIGINAL ARTICLE

Risk of Stroke, Heart Attack, and Diabetes Complications Among Veterans With Spinal Cord Injury

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ABSTRACT. Banerjea R, Sambamoorthi U, Weaver F, Maney M, Pogach LM, Findley T. Risk of stroke, heart attack, and diabetes complications among veterans with spinal cord injury. Arch Phys Med Rehabil 2008;89:1448-53.

Objectives: To compare the rates of diabetes and macrovascular conditions in veterans with spinal cord injury (SCI) and to examine variations by patient-level demographic, socioeconomic, access, and health status factors.

Design: A retrospective analysis. Diabetes status was classified by merging with diabetes epidemiology cohort using a validated algorithm. Chi-square tests and logistic regressions used to compare rates in macro- and microvascular conditions in veterans with and without diabetes.

Setting: Veteran Health Administration clinic users in fiscal year (FY) 1999 to FY 2001.

Participants: SCI patients (N=8769) with diabetes (n=1333), in FY 2000, identified through the SCI registry.

Interventions: Not applicable.

Main Outcome Measures: Macrovascular and microvascular conditions in the next year (February 2001). Derived from *International Statistical Classification of Diseases, 9th Revision, Clinical Modification*, codes in the patient treatment files.

Results: Overall, 15% of SCI veterans were identified with diabetes but this was an underestimate due to high mortality (8%). Among SCI veterans with diabetes, 49% had at least one macrovascular condition and 54% had microvascular conditions compared with 24% and 25% of those without diabetes ($P<.001$).

Conclusions: Our study highlights the highly significant relationship between diabetes and macro- and microvascular conditions in veterans with SCI. Neurologic deficit combined with increased insulin resistance has a greater macrovascular impact on SCI veterans than on those who do not have diabetes. Increasing age and physical comorbidities compound the problem.

Key Words: Rehabilitation; Spinal cord injuries; Veterans.

Published by Elsevier Inc. on behalf of the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation

THE NUMBER OF PEOPLE in the United States living with SCI and disorders has been estimated to range between 222,000 and 285,000.[1] Nearly 1 in 5 (44,000) are veterans who are eligible for VHA medical care, and all veterans who sustain SCI are eligible for VA treatment even if the injury was not service related.[2] The VHA has the largest single network of SCI care in the nation and provided medical care to 22,800 veterans with SCI in 2004.

People with SCI have been reported to have a higher risk for insulin resistance, atherogenic lipid profile, and metabolic syndrome, precursors of diabetes and macrovascular disease,[3,4] compared with age-matched general populations. Indeed, a recent small study suggests that diabetes is an independent risk factor for mortality.[5] Studies have underlined the increased prevalence of diabetes in older adults[6,7] and compared with the non-SCI population, aging patients with SCI have less lean body mass and greater adiposity.[8] In a recent study of veterans with SCI, around 20% were found to be obese and 33% were overweight.[9] Studies also suggest that patients with SCI have premature coronary heart disease that may be due to sedentary lifestyle, weight gain, and metabolic changes.[9,10] Others have observed a higher incidence of hypertension and ischemic heart disease.[4,11] Data from the 1990s indicate that respiratory and cardiovascular conditions combined account for over half of all deaths in patients with SCI.[12-14] Others studies have pointed to the worse outcomes for diabetes patients including epidural abscesses and spinal cord infarctions.[15,16] Thus the effects of increased diabetes risk have added a greater burden of SCI and comorbidities in older patients.[6,7,17]

Increasing prevalence of cardiovascular risk factors is clinically important in managing persons with SCI. Clinicians are well aware of problems in diabetes and its related macrovascular and microvascular conditions in persons with SCI. A cursory examination of the data does not support this view, because prevalence rates do not differ from the general VA population. However, when the analysis is extended to include those who have recently died, the situation changes dramatically. Given the markedly higher death rates in those with both diabetes and SCI, there must be an influx of new cases each year in order for prevalence rates to remain the same. Whether this influx consists of persons with SCI who develop diabetes, or persons with diabetes who develop SCI, is an important

List of Abbreviations

CI	confidence interval
FY	fiscal year
ICD-9-CM	*International Statistical Classification of Diseases, 9th Revision, Clinical Modification*
OR	odds ratio
SCI	spinal cord injury
VA	Veterans Affairs
VHA	Veterans Health Administration

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Presented as a poster to American Public Health Association, November 4–8, 2006, Boston, MA.

Supported by the VA Clinical Service Research and Development and the Health Services Research Enhancement Award Program (grant no. REA-03-021).

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit upon the authors or upon any organization with which the authors are associated.

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0003-9993/08/8908-00801$34.00/0
doi:10.1016/j.apmr.2007.12.047

question that can be answered in future studies as this project collects additional data years. In addition, the increased longevity of persons with SCI, which, on average, is now 20 years or more after their injury, and may be up to 40 years for younger patients,[18,19] underscores the importance of aging and its comorbidities in the population with SCI. However, the association between SCI, macrovascular disease and diabetes in persons with SCI and specifically veterans with SCI, has not been determined on a large scale population. The primary aim of this study was to examine prevalence of diabetes among VHA clinic users with SCI, and compare rates of macrovascular and microvascular conditions in SCI veterans with and without diabetes.

METHODS

Veterans With SCIs or Disorders

Our data include information from the spinal cord disorders registry, which consists of a refined cohort of veterans who use VHA medical care, have an SCI diagnosis, and use SCI-specific health care services (SCI inpatient bed section or SCI outpatient clinic stop). The current spinal cord disorders registry requires that the facility enter information about the veteran regarding their demographics, level and completeness of injury, etiology, and other characteristics. However, because it is voluntary, not all veterans with SCI or disorders are recorded on the registry. Participation is less common at non-SCI center facilities (F. Weaver, PhD, personal communication, July 5, 2006).

The spinal cord disorders registry is cumulative (N=36,987) and has patients with dates of onset of SCI condition through December 2006. The exclusionary criteria were: (1) those who had no date of onset; (2) date of onset occurred later than our baseline year (FY 2000); and (3) those who died during or before FY 1999. This yielded a sample of 11,281. These data were further merged with those who used the VHA system in FY 1999–2001 and were still alive at the end of our study outcome year of FY 2001, yielding a final sample (n=8769). Use was measured by any inpatient or face-to-face outpatient visits in the VHA. Thus we arrived at our cohort of SCI veterans who were using the system in FY 1999–2001, had a diagnosis of SCI as of September 30, 2000, and were alive at the end of FY 2001 (n=8769).

Veterans With SCI and Diabetes

We merged our cohort of SCI veterans using the VHA clinics (n=8769) with the diabetes epidemiology cohort of FY 1999 and FY 2000 (N=738,371). Diabetes epidemiology cohort is a multi-year, dynamic cohort of patients with diabetes who use the VHA for health care. Details of identification and construction of the cohort are described elsewhere.[20] In the final cohort 1333 veterans (15% of n=8769) with SCI were identified and flagged as also having a diagnosis of diabetes (the remaining 85%, n=7436, were flagged as nondiabetes patients).

Measures: Dependent Variables

Macrovascular conditions. We identified the presence of any macrovascular condition(s) based on conditions derived from ICD-9-CM diagnosis codes in the VHA inpatient and outpatient files in the year 2000. Macrovascular conditions included stroke (codes 431, 433.00, 434.00, 435.8-.9, 438.0, 435.00), coronary artery disease (codes 410.0, 411.0, 411.1, 411.81−.89, 412–413, 413.0, 414, 414.00), congestive heart failure (codes 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 428, 428.0−.1, 428.9), arrhythmia (codes 423, 423.0−.2, 423.8−.9, 427.31), peripheral vascular disease (codes 250.7, 440.2, 440.20, 440.8−.9, 442.2−.3, 443), and gangrene (code 785.4).

Microvascular conditions. Microvascular conditions were also identified through ICD-9-CM codes and included renal conditions (codes 274.1, 274.10−.11, .19, 403.10, 403.90−.91, 404.10−.13, 404.90−.93, 581.0–583.0, 585–587, 590.0, 593.6, 593.9, 753.12−.14), nephritis (codes 250.4, 403.00−.01, 404.00−.03, 405.01, 453.3, 584, 580.0, 590.1−.3, 590.8, 593.81, 866), end-stage renal disease (codes 458.21, E879.1, V56, V451), dialysis (389.5, 392.7, 394.2−.3, 399.5, 549.8), retinopathy (codes 250.50−.53, 362.0−.02), ulcers (codes 700, 681.10−.11, 682.7, 707.1, 730.76−.77), and amputation (code 841.0).

Independent Variables

Independent variables consisted of veteran's demographic, economic, access to care, and health status characteristics measured in FY 2000. In addition, we included life style variables (eg, substance abuse) and level of SCI injury. These were derived from the VHA administrative and Medicare claims data. Demographic characteristics were represented by sex, race and ethnicity (white, black, Latino, other), age (<50y, 50−64y, 65–74y, ≥75y), and marital status (married vs others). Region (Northeast, Midwest, South, West), urbanicity (urban, rural), and Medicare fee-for-service enrollment (FY 2000, FY 2001) was also determined and controlled for in analysis. Health status measures included physical comorbidity (number of conditions), severe mental illness, other mental illness, and substance abuse. Physical comorbidity was measured using the Selim index (physical index) derived from ICD-9-CM codes.[21] Mental illness included schizophrenia (ICD-9-CM code 295), bipolar disorder (codes 296), anxiety (codes 300.0, 300.2, 300.3), depression (codes 296.2, 296.3, 300.4, 309.1, 311) and posttraumatic stress disorder (code 309.81), other psychosis (codes 296.9, 297−298), and other mental illnesses (codes 300.5−.9, 308.0, 300, 309.0−.00).

Life style factors. Substance abuse included presence of substance abuse (alcohol, tobacco, drug) by ICD-9-CM codes (drug abuse: codes 292, 304, 305.2−.9, tobacco: code 305.1; opium: code 304; alcohol abuse: codes 291.1−.9, 303, 305.0, 265.2, 357.5, 425.5, 571.0, 571.2−.3, 535.3, 790.3).

SCI level of injury and duration. To compensate for high levels of missing data in the registry (28%) regarding SCI level of injury, we have supplemented information from the VHA and Medicare patient treatment files. With the supplementation, we now have only 2.2% missing. To the extent permitted by the data, we controlled for the effect of level of SCI and/or neurologic deficit and duration of SCI in our regression analysis.

Statistical Procedures

We used chi-square tests to test unadjusted subgroup differences in the dependent variables. To examine the relationship between macrovascular and microvascular conditions and diabetes, we conducted chi-square tests for each patient characteristic. For example, we tested the relationship between macrovascular and microvascular conditions and diabetes for men and women separately. Although the battery of tests may seem unconventional, such approaches have been used to study subgroup differences in antidepressant use.[22-24] Olfson et al[22] used a battery of analyses to analyze subgroup differences in antidepressant use over time. Rosenthal et al[23] (see their table 5) also used the same technique to assess ORs of death among patients from VA versus private sectors within subpopulation groups.