

Key Factors Associated with Major Depression in a National Sample of Stroke Survivors

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Background: Depression, one of the most common complications encountered after stroke, is associated with poorer outcomes. The aim of this study was to determine the factors independently associated with and predictive of poststroke depression (PSD). *Methods:* We assessed the prevalence of depression (Patient Health Questionnaire [PHQ-8] score >10) among a national sample of adults (≥20 years) with stroke who participated in the National Health and Nutrition Examination Surveys from 2005 to 2010. Logistic regression and random forest models were used to determine the factors associated with and predictive of PSD, after adjusting for sociodemographic and clinical factors. *Results:* Of the 17,132 individuals surveyed, 546 stroke survivors were screened for depression, and 17% had depression, corresponding to 872,237 stroke survivors with depression in the United States. In the logistic regression model, after adjustment for sociodemographic variables, poverty (poverty index <200% versus ≥200%, odds ratio [OR] 2.61, 95% confidence interval [CI] 1.23-5.53) and 3 or more medical comorbidities (OR 1.59, 95% CI 1.01-2.49) were associated with higher odds of PSD; increasing age was associated with lower odds of PSD (per year OR .95, 95% CI .94-.97). In the random forest model, the 10 most important factors predictive of PSD were younger age, lower education level, higher body mass index, black race, poverty, smoking, female sex, single marital status, lack of cancer history, and previous myocardial infarction (specificity = 70%, sensitivity = 64%). *Conclusion:* Although numerous factors were predictive of developing PSD, younger age, poverty, and multiple comorbidities were strong and independent factors. More aggressive screening for depression in these individuals may be warranted. **Key Words:** Depression—stroke—NHANES—poststroke depression—factors.

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Introduction

Poststroke depression (PSD) is one of the most common consequences of stroke, affecting approximately one third of stroke survivors.¹⁻⁵ Recent studies have indicated an association between PSD and poststroke physical morbidity and mortality; those with PSD have a higher risk for suboptimal recovery, recurrent vascular events, and an overall poorer quality of life.^{1-4,6}

Although the adverse effects of PSD have been well studied, the nature of PSD itself remains unclear. Factors most consistently associated with PSD include living alone, poststroke isolation or distress, physical disability, and a history of depression, stroke, or other psychiatric conditions.¹ The roles of factors such as sex, age, and socioeconomic status remain less clear.^{1,7,8} Identification of

factors associated with PSD may permit earlier recognition of PSD and prompt initiation of interventions to prevent or treat PSD. The purpose of this study was to determine which factors were independently associated with and predictive of depression among individuals with a history of stroke in a national sample of the U.S. population.

Methods

Patient Population

The National Health and Nutrition Examination Surveys (NHANES) are cross-sectional samples of the U.S. civilian noninstitutionalized population conducted by the National Center for Health Statistics (NCHS), a branch of the Centers for Disease Control and Prevention. We assessed data from NHANES from 2005 to 2010. The NCHS institutional review board approved the protocols for conduct of the NHANES and informed consent was obtained from all participants. The sampling plan followed a complex, stratified, multistage probability cluster design, with oversampling of non-Hispanic blacks, Mexican Americans, and the elderly, to enhance the precision of prevalence estimates in those groups.⁹

Interviews were conducted in sampled households, and all subjects were invited to participate in medical examinations that were conducted at nearby mobile examination centers. The interviews collected demographic, socioeconomic, dietary, and health-related information. Mobile examinations consisted of medical and dental examinations, physiological measurements, and laboratory tests. Detailed descriptions of the plan and operation of each survey have been previously published.⁹ NHANES weights were calculated according to the analytical guidelines provided in the NHANES online documentation. All estimates were weighted in order to obtain nationally representative estimates.

Statistical Analyses

Stroke was defined by self-report. Presence of depression was defined as Patient Health Questionnaire (PHQ-8) scores of 10 or more. Using the NHANES 2005-2010, the predictors of depression among stroke survivors aged 20 years or more in the United States were assessed. The following potential predictors were assessed: age, sex, race/ethnicity, household income as measured by the income to poverty index ratio, education level (less than high school, high school, more than high school), marital status, body mass index, smoking, and medical history including congestive heart failure, coronary artery disease, angina pectoris, myocardial infarction (MI), diabetes, emphysema, chronic bronchitis, liver disease, and cancer (except skin cancer). We performed two logistic regression models. The first model adjusted for age, sex, race/ethnicity, and

other sociodemographic factors (education level, poverty index, marital status). The second model also adjusted for major medical comorbidities as individual factors or by total number of comorbidities (0, 1, 2, and ≥ 3). The discrimination ability of the logistic model was determined by computing the specificity, sensitivity, and accuracy using the receiver operating characteristic curve analysis under the final model.

Random Forest

Random forest model was used to identify the factors that were associated with and predictive of PSD, as another multivariate strategy to the above logistic model. The random forest model consists of an ensemble of classification trees calculated on bootstrap samples of the original data (training samples). For each tree, a random subset of the input variables is used to find the best split at each node of the tree. Observations that are not used in building the current tree constitute the so-called "out of bag" (OOB) sample (testing samples). For each observation, the final class prediction is made by a majority vote across all trees.¹⁰ We used $N = 2000$ as the total number of trees in the forest and $n = 4$ as the number of input variables that are randomly chosen at each split.

Variable Importance and Final Model Selection

We sorted the 17 variables in the order of importance using the mean decrease in Gini index. To select the final model, we used backward elimination of variables using out of box error.¹¹ We chose the model with the smallest number of variables and whose out of box error was within 1 standard error of the best fitting model.

Prototypes

Using the 10 variables chosen, we computed a proximity or ten-dimensional distance measure among all n observations. For each index observation, we could determine how many of $K = 86$ nearest neighbors belonged to the same group (depression or not depression) as the index observation. We used $K = 86$ because the smaller group had 87. We defined the "best/purest" observation as that observation with the greatest number of its 86 nearest neighbors who belonged to the same group, and called this group of up to 86 neighbors the "prototype group." We then reported summary statistics ("medoid") on the prototype depression group compared to the prototype nondepression group. Prototypes for each class were computed using the function "ClassCenter" ("RandomForest" package in R version 2.15.1). All analyses were performed in SAS version 9.4 (Copyright © 2002-2012 by SAS Institute Inc., Cary, NC) and in R version 2.15.1 (RandomForest package).

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