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Depression and risk of hospitalization for pneumonia in a cohort study of older Americans

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A B S T R A C T

Objective: The aim of this study is to determine if depression is independently associated with risk of hospitalization for pneumonia after adjusting for demographics, medical comorbidity, health-risk behaviors, baseline cognition and functional impairments.

Methods: This secondary analysis of prospectively collected data examined a population-based sample of 6704 Health and Retirement Study (HRS) (1998–2008) participants > 50 years old who consented to have their interviews linked to their Medicare claims and were without a dementia diagnosis. The eight-item Center for Epidemiologic Studies Depression Scale and/or International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) depression diagnoses were used to identify baseline depression. ICD-9-CM diagnoses were used to identify hospitalizations for which the principal discharge diagnosis was for bacterial or viral pneumonia. The odds of hospitalization for pneumonia for participants with depression relative to those without depression were estimated using logistic regression models. Population attributable fractions were calculated to determine the extent that hospitalizations for pneumonia could be attributable to depression.

Results: After adjusting for demographic characteristics, clinical factors, and health-risk behaviors, depression was independently associated with increased odds of hospitalization for pneumonia (odds ratio [OR]: 1.28, 95% confidence interval [95%CI]: 1.08, 1.53). This association persisted after adjusting for baseline cognition and functional impairments (OR: 1.24, 95%CI: 1.03, 1.50). In this cohort, 6% (95%CI: 2%, 10%) of hospitalizations for pneumonia were potentially attributable to depression.

Conclusion: Depression is independently associated with increased odds of hospitalization for pneumonia. This study provides additional rationale for integrating mental health care into medical settings in order to improve outcomes for older adults.

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Introduction

Each year, nearly 400,000 Americans ages 65 and older are hospitalized for pneumonia [1]. Pneumonia is the third most common cause of hospitalization among Americans 65–84 years old, and the second most common among those over age 85 [2]. Nearly 11% of older adults hospitalized for pneumonia die within 30 days of hospitalization [1], and approximately half die within one year [3]. Beyond increased mortality, hospitalization for pneumonia may raise the risk of subsequent cognitive and functional decline [4]. In addition, pneumonia-related hospitalizations are a burden to the American public healthcare system,

costing Medicare an estimated $7.3 billion annually [1], in part due to early rehospitalizations [5]. Importantly, many hospitalizations for pneumonia could be prevented [6], and the Centers for Medicare and Medicaid Services (CMS) has begun actively incentivizing efforts to reduce rehospitalizations within 30 days of initial hospitalization for pneumonia [7]. While several studies have identified increased age and greater medical comorbidity as associated with development of pneumonia [8,9], there remains a need to identify potentially modifiable risk factors in order to prevent pneumonia-related hospitalizations.

Depressive disorders are among the most common mental disorders in older adults [10]. Notably, over 20% of older adults with congestive heart failure (CHF) or chronic obstructive pulmonary disease, common chronic medical conditions associated with risk of developing pneumonia, may also have major depression [11,12]. However, no study to date has examined the association between depression and risk of hospitalization for pneumonia. Although some studies have controlled for

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depression as a potential risk factor for pneumonia and pneumonia-related hospitalizations [13–18], none of these were primarily designed to examine depression as an independent risk factor.

The present study utilizes data from an ongoing longitudinal study of health outcomes in older adults to examine if depression is independently associated with increased risk of hospitalization for pneumonia after adjusting for demographic characteristics, medical comorbidity, and health-risk behaviors. We also sought to determine if any association found between depression and pneumonia hospitalization remained even after adjusting for potential mediators such as cognitive status and functional disability.

Methods

Population

This study is a secondary analysis of prospectively collected, nationally representative data from Americans over age 50 participating in the Health and Retirement Study (HRS). The HRS began in 1992, and to date, over 31,000 individuals have participated. Subjects are interviewed every two years. The HRS follow-up rate has exceeded 90–95% (including proxies) with over 80% of eligible respondents consenting to linkage of their Medicare claims records with study data [19]. The HRS protocol was approved by the University of Michigan Institutional Review Board. Participants provided informed consent upon enrollment and again for linkage to Medicare claims.

Our sample was comprised of HRS respondents interviewed in 1998 or 2000 who consented to linkage of their Medicare claims records. We followed them through death or the 2008 interview. We excluded individuals with an International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) dementia diagnosis (codes 290.0–290.42, 291.2, 294.1, 294.8, 331.0, 331.1, 331.11, 331.19, or 331.82) at baseline from our analyses since dementia is known to raise the risk of pneumonia as well as hasten death and may have a bi-directional relationship with depression [20–23].

Primary independent variable

The primary independent variable in our analyses was baseline (i.e., the 1998 or 2000 HRS interview) presence of depression. Depression was defined as either a score of ≥ 4 on the eight-item Center for Epidemiologic Studies Depression Scale (CES-D-8) [24] at the baseline HRS interview (obtained from self-respondents only [24]) or a Medicare claims-based depression diagnosis in the year before baseline based on ICD-9-CM codes 296.2, 296.3, 298.0, 300.4, or 311.0. The CES-D-8 cutoff score of ≥ 4 has been found to be comparable to the cutoff score of ≥ 16 on the full CES-D [24], and has been used previously in other relevant studies [4,25,26].

Demographics, clinical characteristics and health-risk behaviors

Demographic information (e.g., age, sex, race, education, marital/partnered status, and dual Medicare–Medicaid eligibility) was obtained from the HRS interviews. Elixhauser comorbidity diagnoses [27] as well as the number of hospitalizations in the year before baseline were obtained from Medicare claims. Information on alcohol use and smoking came from the HRS interviews. Prior substance abuse diagnoses (ICD-9-CM codes 303.0–305.0) were obtained from Medicare claims.

Cognitive and functional status

Cognition was assessed using the modified Telephone Interview for Cognitive Status (TICSm), a validated composite measure comprised of items testing immediate and delayed recall, working memory with serial sevens subtraction, and backwards counting testing attention and

processing speed [28]. Scores range from 0 to 27, with higher scores indicating better cognitive functioning [28].

Functional status was ascertained by asking participants (or their proxies) if they required assistance with any of six activities of daily living (ADLs): walking, dressing, bathing, eating, getting into/out of bed, and toileting, or five instrumental ADLs (IADLs): preparing a hot meal, grocery shopping, making telephone calls, taking medicines, and managing money.

Outcome of interest

Our outcome of interest was the first hospitalization for pneumonia occurring during the follow-up period. We used ICD-9-CM codes (see Online Supplement) to identify hospitalizations for which the principal discharge diagnosis was for bacterial or viral pneumonia based on validated algorithms [6,29].

Statistical analysis

We present descriptive data as means and standard deviations (SDs) or proportions. We examined bivariate associations between baseline demographic, clinical, health-risk behavioral and functional characteristics and depression using one-way analysis of variance for normally distributed continuous variables and Chi-squared or Fisher's exact tests for categorical variables.

To estimate odds ratios (ORs) and 95% confidence intervals (95%CIs) for the association of baseline depression with hospitalization for pneumonia, we used logistic regression models with robust error variances. First, we tested the association of depression with pneumonia hospitalization without adjustment. We then sequentially adjusted for potential confounders chosen a priori based on prior research identifying their associations with depression and/or health outcomes, including hospitalization for pneumonia, among older adults [5,8,9,30]. Non-normally distributed covariates were categorized. The sequence of adjustments was: 1) demographic characteristics (e.g., age, sex, race categorized as white versus non-white, education categorized as <high school graduate versus $\geq$ high school graduate, marital/partnered status categorized as married/partnered versus single/separated/widowed, dual Medicare–Medicaid eligibility); 2) clinical characteristics (e.g., non-psychiatric Elixhauser comorbidities, number of hospitalizations in the year before baseline); and 3) health-risk behaviors (e.g., alcohol use categorized by the number of drinks per day, smoking status, and substance abuse diagnosis). In a final step, we adjusted for cognitive status (i.e., TICSm score) and total ADL/IADL impairments categorized by their interquartile range in order to examine the extent to which depression remained associated with pneumonia hospitalization even after considering these two potential mediators.

To determine the extent that any increase in hospitalizations for pneumonia could be attributable to depression, we calculated the population attributable fraction (PAF). The PAF for depression and its 95%CI was estimated using the following formula: P(OR − 1) / (1 + P[OR − 1]). In this formula, P represents the prevalence of depression and OR is the adjusted odds ratio for the association of depression with hospitalization for pneumonia [31].

In a set of sensitivity analyses, we estimated the association of baseline depression with pneumonia hospitalization using only the CES-D-8 threshold to define depression. In the first sensitivity analysis, we used a CES-D-8 cutoff score of ≥ 4; in the second, we used a cutoff score of ≥ 3, which has been found to have a sensitivity of 71% and a specificity of 79% for the diagnosis of major depression versus structured interview [32]. Since the CES-D-8 was only administered to self-respondents, this analysis only included the 6137 self-respondents without a dementia diagnosis.

We used two-sided significance tests for all analyses with statistical significance set at $P < 0.05$. Analyses were performed with appropriate