

# Functional Disability, Cognitive Impairment, and Depression After Hospitalization for Pneumonia

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## ABSTRACT

**OBJECTIVE:** The study objective was to examine whether hospitalization for pneumonia is associated with functional decline, cognitive impairment, and depression, and to compare this impairment with that seen after known disabling conditions, such as myocardial infarction or stroke.

**METHODS:** We used data from a prospective cohort of 1434 adults aged more than 50 years who survived 1711 hospitalizations for pneumonia, myocardial infarction, or stroke drawn from the Health and Retirement Study (1998-2010). Main outcome measures included the number of Activities and Instrumental Activities of Daily Living requiring assistance and the presence of cognitive impairment and substantial depressive symptoms.

**RESULTS:** Hospitalization for pneumonia was associated with 1.01 new impairments in Activities and Instrumental Activities of Daily Living (95% confidence interval [CI], 0.71-1.32) among patients without baseline functional impairment and 0.99 new impairments in Activities and Instrumental Activities of Daily Living (95% CI, 0.57-1.41) among those with mild-to-moderate baseline limitations, as well as moderate-to-severe cognitive impairment (odds ratio, 2.46; 95% CI, 1.60-3.79) and substantial depressive symptoms (odds ratio, 1.63; 95% CI, 1.06-2.51). Patients without baseline functional impairment who survived pneumonia hospitalization had more subsequent impairments in Activities and Instrumental Activities of Daily Living than those who survived myocardial infarction hospitalization. There were no significant differences in subsequent moderate-to-severe cognitive impairment or substantial depressive symptoms between patients who survived myocardial infarction or stroke and those who survived pneumonia.

**CONCLUSIONS:** Hospitalization for pneumonia in older adults is associated with subsequent functional and cognitive impairment. Improved pneumonia prevention and interventions to ameliorate adverse sequelae during and after hospitalization may improve outcomes.

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**KEYWORDS:** Cognitive impairment; Depression; Functional impairment; Hospitalization; Pneumonia

Pneumonia accounts for an estimated 390,000 hospitalizations among older adults annually, costing Medicare more than \$7.3 billion.<sup>1</sup> Pneumonia hospitalizations are projected to nearly double by 2040.<sup>2</sup> As pneumonia-related in-hospital mortality decreases,<sup>3</sup> the number of older pneumonia survivors will

increase dramatically. Although approximately half of older pneumonia hospitalization survivors die within 1 year,<sup>4</sup> little is known about other ways that survivors are affected.

Older adults hospitalized or receiving outpatient treatment for pneumonia have reported diminished quality of

**Funding:** This work was supported by Grants KL2 TR000421, K08 HL091249, R01 AG030155, and U01 AG09740 from the National Institutes of Health. The Health and Retirement Study is performed at the Institute for Social Research, University of Michigan.

**Conflict of Interest:** None. The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs, the National Institutes of Health, or the US government.

**Authorship:** All authors had access to the data and played a role in writing this manuscript.

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life,<sup>5,6</sup> although the reasons why are unclear. Survivors of critical illnesses are at risk for incident cognitive and functional impairment<sup>7</sup> and have high rates of depression.<sup>8</sup> However, the rates of these adverse outcomes after hospitalization for specific noncritical acute illnesses such as pneumonia are unknown. Determining pneumonia survivors' long-term risks of functional disability, cognitive impairment, and depression is crucial given the consequences of these outcomes<sup>9-11</sup> and their potential to create substantial chronic care needs.<sup>12-14</sup>

The present study uses an ongoing longitudinal investigation of older Americans to determine whether hospitalization for pneumonia is associated independently with functional disability, cognitive impairment, and depression. We also examined how the risks of these outcomes compare with those seen after hospitalizations for myocardial infarction or stroke, 2 acute conditions recognized as associated with subsequent functional decline, cognitive impairment, and depression.<sup>15-20</sup>

## MATERIALS AND METHODS

### Population

Our study is a secondary analysis of data from the Health and Retirement Study (HRS), a prospective longitudinal investigation of adults aged more than 50 years in the United States. The details of the HRS have been described.<sup>7,8</sup> The HRS protocol was approved by the University of Michigan Institutional Review Board.

We studied all HRS respondents with at least 1 interview from 1998 to 2006 and for whom there were Medicare claims-based data for a subsequent hospitalization for pneumonia, myocardial infarction, or stroke from 1998 to 2007. All patients were followed through death or the 2010 interview. Our analyses focus on hospitalizations of patients who survived long enough to complete at least 1 follow-up interview.

### Demographic and Clinical Characteristics

Data on demographics (eg, age, race/ethnicity, sex, education, and marital/partnered status) and health-risk behaviors (eg, alcohol use and smoking) were derived from HRS interviews. Baseline Charlson Comorbidity Score<sup>21</sup> and hospitalization-related characteristics (length of stay, intensive care unit or coronary care unit admission, and requirements for mechanical ventilation, major surgery, and dialysis) were derived from Medicare claims.

## Definitions of Conditions

We used International Classification of Diseases, Ninth Revision, Clinical Modification diagnostic codes to identify hospitalizations for pneumonia, myocardial infarction, and stroke based on validated algorithms.<sup>22-24</sup> Hospitalizations were included if the principal discharge diagnosis was for 1 of the 3 conditions of interest and they were longer than 1 day.

### Functional Impairment

To examine functional disability, respondents (or their proxies) were asked if they required assistance with any of 6 activities of daily living (walking, dressing, bathing, eating, getting into/out of bed, and toileting) or 5 instrumental activities of daily living (preparing a hot meal, grocery shopping, making telephone calls, taking medicines, and managing money). We defined baseline mild-to-moderate disability as 1 to 3 impairments in Activities and Instrumental Activities of Daily Living, and we defined baseline moderate-to-severe disability as  $\geq 4$  impairments.<sup>7</sup>

## CLINICAL SIGNIFICANCE

- We found that hospitalization for pneumonia in older adults was independently associated with subsequent functional decline, approximately 2.5 times the odds of subsequent moderate-to-severe cognitive impairment and 1.6 times the odds of subsequent substantial depressive symptoms.
- Pneumonia hospitalization survivors without baseline functional impairment had more functional impairments than myocardial infarction hospitalization survivors.
- Interventions to ameliorate adverse outcomes after hospitalization for pneumonia may improve outcomes.

### Cognitive Impairment

Cognitive impairment was assessed using versions of the modified Telephone Interview for Cognitive Status.<sup>25,26</sup> Proxies completed cognitive impairment assessments for patients unable to be interviewed themselves. We defined thresholds for mild-to-moderate and moderate-to-severe cognitive impairment on the basis of previous HRS studies and the methods used for the Aging, Demographics, and Memory Study.<sup>7,8,27,28</sup>

### Depression

Depression was assessed at each HRS interview using the 8-item version of the Center for Epidemiologic Studies Depression Scale<sup>29</sup> from patients (not proxies).<sup>30</sup> We used a cutoff score of  $\geq 4$  to define substantial depressive symptoms because this threshold is comparable to the cutoff score of  $\geq 16$  on the full Center for Epidemiologic Studies Depression Scale<sup>30</sup> and has been used in prior studies.<sup>8,12,31</sup>

### Analysis

Hospitalization was the unit of analysis for all analyses. For analyses of post-hospitalization functional status, our outcome was the total number of impairments in Activities and Instrumental Activities of Daily Living. For unadjusted analyses, we grouped patients by the number of HRS interviews they completed since hospitalization. For multivari-

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