Title

Depressive Symptoms After Hospitalization in Older Adults: Function and Mortality Outcomes

Journal

Journal of the American Geriatrics Society, 60(12)

ISSN

0002-8614

Authors

Pierluissi, Edgar
Mehta, Kala M
Kirby, Katharine A
et al.

Publication Date

2012-12-01

DOI

10.1111/jgs.12008

Peer reviewed

Published in final edited form as:
J Am Geriatr Soc. 2012 December ; 60(12): 2254–2262. doi:10.1111/jgs.12008.

Depressive Symptoms after Hospitalization in Older Adults: Function and Mortality Outcomes

Edgar Pierluissi, MD[1], **Kala M. Mehta, D.Sc., MPH**[1,2], **Katharine A. Kirby, MS**[1], **W. John Boscardin, PhD**[1,2,3], **Richard H. Fortinsky, PhD**[4], **Robert M. Palmer, MD, MPH**[5], and **C. Seth Landefeld, MD**[1,2,3]

[1]Division of Geriatrics, University of California, San Francisco, San Francisco, CA

[2]Health Services Research Enhancement Award Program, San Francisco Veterans Affairs Medical Center, San Francisco, CA

[3]Department of Epidemiology and Biostatistics, University of California, San Francisco, San Francisco, CA

[4]University of Connecticut Center on Aging, Farmington, CT

[5]Division of Geriatric Medicine and Gerontology, University of Pittsburgh, Pittsburgh, PA

Abstract

Objectives—To determine the relationship between depressive symptoms after hospitalization and survival and functional outcomes.

Design—Secondary analysis of a prospective cohort study

Setting—General medical service of two urban, teaching hospitals in Ohio

Participants—Hospitalized patients, age 70 years or older.

Measurements—We measured 10 depressive symptoms, instrumental activities of daily living (IADL), and basic activities of daily living (ADL) at hospital discharge and 1, 3, 6, and 12 months later. Using all data points, we determined subject-specific changes in depressive symptoms (slopes). We also defined four groups according to the number of depressive symptoms (≤3 symptoms, Low; 4–10 symptoms, High) at discharge and follow-up: Low-Low, Low-High, High-Low, and High-High. We measured mortality at 3, 6, and 12 months after hospital discharge.

Results—Both subject-specific discharge depressive symptoms and change in depressive symptoms over time (slopes) were associated ($P<0.05$) with functional and mortality outcomes. At 1 year, more patients in the Low-Low depressive symptom group were alive and independent in instrumental activities of daily living (IADL) and basic activities of daily living (ADL), compared

Corresponding Author and Requests for Reprints: Edgar Pierluissi, MD University of California, San Francisco, San Francisco General Hospital 1001 Potrero Avenue Room 5H17 San Francisco, CA 94110 Ph: 415-206-3913 fax: 415-206-8965 epierluissi@medsfgh.ucsf.edu.

Conflict of Interest: The editor in chief has reviewed the conflict of interest checklist provided by the authors and has determined that the authors have no financial or any other kind of personal conflicts with this paper.

Author contributions: Dr. Pierluissi had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Drs. Landefeld, Palmer and Fortinsky contributed to original study design and acquisition of data. Drs. Pierluissi and Mehta acquired data from the National Death Index. Drs. Pierluissi, Mehta, Boscardin, Landefeld and Ms. Kirby contributed to the current study design and concept, data analysis and interpretation of data, drafting of the manuscript, and study supervision. All authors (Drs. Mehta, Pierluissi, Boscardin, Palmer, Fortinsky and Landefeld and Ms. Kirby) contributed to the critical revision of the manuscript for important intellectual content, helped conceptualize ideas, interpreted findings, and reviewed drafts of the manuscript.

to the Low-High group (49% vs 37%, P=0.02).and more patients in the High-Low group were alive and independent in IADL and ADL, compared to the High-High group (39% vs 19%, P<0.001).

Conclusion—Both the number of depressive symptoms and the change in the number of depressive symptoms during the year after discharge were associated with functional and mortality outcomes in hospitalized older adults. Fewer patients with persistently high or increasing depressive symptoms after hospitalization were alive and functionally independent 1 year later than patients with decreasing or persistently low symptoms, respectively.

Keywords

depression symptoms; hospitalized older adults; elderly; function; mortality

INTRODUCTION

Depressive symptoms and disorders are common in hospitalized older adults and are associated with significant morbidity and mortality after discharge. Approximately 10% of older adults hospitalized with medical illness have major depression disorder[1] and up to one-third have significant depressive symptoms.[2,3] Single measures of depressive symptoms in hospitalized older adults are associated with worse quality of life[4,5], function[6], caregiver mental health[7], and may be associated with increased mortality.[3,8–11] Older hospitalized adults with depression also use more healthcare resources.[2,12–14] Despite this, little is known about the course of depressive symptoms after hospitalization or their effects on health outcomes.

Recent studies of community-dwelling older adults have identified distinct depressive symptom trajectories[15,16] and persistently high numbers of depressive symptoms were associated with increased mortality.[15] Only one previous study has evaluated depressive symptom trajectories in recently hospitalized patients,[17] but this study did not assess the association of depressive symptom trajectories with patient outcomes.

To address this gap, we measured depressive symptoms at hospital discharge and at 1, 3, 6 and 12 months post-discharge. We first used a repeated measures longitudinal analysis to assess the association between the number of discharge depressive symptoms and the change in the number of depressive symptoms over time with functional and mortality outcomes. Based on the associations demonstrated in the repeated measures analysis, we defined four groups according to the number of depressive symptoms (≤3 symptoms, Low; 4–10 symptoms, High) at discharge and follow-up: Low-Low, Low-High, High-Low, and High-High. In reporting results, we take the perspective of a clinician caring for a patient on discharge from the hospital and ask: Which patient characteristics are associated with worsening or persistently high depressive symptom groups?, and, Do survival and functional outcomes differ (a) between the Low-Low and Low-High depressive symptom groups, and (b) between the High-High and High-Low depressive symptom groups?

METHODS

Patient sample

This study is a secondary data analysis of patients enrolled in prospective studies comparing an intervention aimed at improving functional outcomes to usual care. We studied a random sample of patients aged 70 years or older admitted consecutively to the general medical wards of two study hospitals (University Hospitals of Cleveland and Akron City Hospital) from 1993 through 1997.[18,19] Of 11,475 eligible patients, 3,163 were randomly selected on

admission for enrollment and 2,877 agreed to participate. Informed consent was obtained orally from patients or their proxies after randomization and according to procedures approved by the hospital's institutional review board. We combined patients from the intervention and usual care groups as these two groups had similar numbers of depressive symptoms on admission and discharge.

We excluded patients who died during hospitalization (65) or within the first 30 days after hospital discharge (182). Patients who did not complete at least two depression scales (1501) were not included, leaving an analytic cohort of 1129 patients. Patients that were not included were older, more often male, had more comorbidity, higher severity of illness as indicated by the acute physiology component of the Acute Physiology and Chronic Health Evaluation (APACHE) II score,[20] and more functional dependency compared to patients included in the analysis.

Data collection

Trained nurse abstractors obtained information from the medical chart. Trained interviewers obtained information from patients at 6 time points: on admission, at discharge, and at 1, 3, 6, and 12 months after hospital discharge. Research nurses were not involved in patient care and were not aware of the research hypothesis.

Primary measurements

Depressive symptoms were measured using the 10-item Center for Epidemiologic Studies Depression (CES-D) scale. Patients were asked if they felt depressed, felt everything was an effort, had restless sleep, felt happy, felt lonely, felt people were unfriendly, enjoyed life, felt sad, felt people disliked them, or could not get going, for much of the time during past week. The range of the scale is 0–10, with one point for each endorsed symptom (positive items were reverse coded). This instrument has been used to evaluate depression in community-living[21] and hospitalized older adults.[22,23] We used a cutoff of 4 or more depressive symptoms to identify patients with a clinically meaningful number of depressive symptoms since this cutoff demonstrated high sensitivity and specificity in diagnosing major depression in older adults.[21]

Covariates

Sociodemographic characteristics included age, sex, marital status, race, highest educational level, and current living situation. Clinical characteristics included number of admission depression symptoms, comorbid illnesses[26] and severity of illness as indicated by the acute physiology component of the APACHE II score. Albumin was measured in g/dl units and was included based on previous work demonstrating its association with failure to recover ADL function in the year after hospitalization[27] as well as one-year mortality in hospitalized older adults.[19] Cognitive impairment was measured using the Short Portable Mental Status Questionnaire.[28] Patients with >2 errors were classified as having impaired cognitive function. No patient had more than 5 errors in this sample. We measured dependence in bathing, dressing, using the toilet, transferring from bed to chair, and eating using a modified Katz Activities of Daily Living (ADLs) index.[29] We measured dependence in 7 instrumental activities of daily living (IADLs): using the telephone, using public transportation or driving, shopping for groceries, preparing, serving and providing meals, doing light housework, taking medications, and managing finances.[30] Self-rated global health was measured, with ratings of poor, fair, good, very good, and excellent.[31]

Primary Outcomes

Functional disability was defined as dependency in one or more IADL or ADL at the last report or at one year. We defined the one-year and ten-year mortality outcome as death occurring between one month and one and ten years after hospital discharge, respectively. Vital status at one year and date of death was determined during telephone interviews and verified using the National Death Index.[32] Functional and one-year mortality outcomes were combined into four hierarchical, all-inclusive and mutually-exclusive levels: independent in ADL and IADL, independent in ADL and dependent in one or more IADL, dependent in ADL, and dead. Vital status at ten years was determined using the National Death Index.

Missing Data

For most variables, data were missing for fewer than 4% of subjects. There were 4282 opportunities to collect CES-D reports from discharge to the last measurement. Of these assessments, all 10 CES-D items were complete for 67% of assessments, 7–9 items were complete for 14%, 1–6 items were complete for 1%, and no items were completed for 18%. Missing items and assessments were multiply imputed using the ice library.[33] Multiple estimates from the imputed datasets were combined using standard multiple imputation techniques as implemented in the mim library.[34] The ice and mim libraries were available through Stata version 10. Sensitivity analyses using subjects with complete assessment of CES-D measures and using the last observation carried forward technique did not change our results. We present results using the imputed CES-D measures.

Analytic strategy

We used a joint modeling approach to assess the relationship between repeated depressive symptom measures and the one-year outcomes.[35] We fit a mixed effects linear trajectory model using all CES-D measures to determine subject-specific intercepts (i.e. estimated CES-D score at time of discharge) and subject-specific slopes of CES-D scores over time. Higher order polynomial models for the subject-specific depressive symptom measures over time did not yield substantially better fit. The subject-specific intercepts and slopes were then included as predictors in an ordinal logistic regression using the four-level, one-year outcome variable. This analysis tests the hypothesis that both the number of discharge depressive symptoms and the rate of change in the number of depressive symptoms over time are independently associated with one-year outcomes. The ordinal logistic regression portion of the linear model satisfied the proportional odds assumption ($p=0.14$). In a separate analysis, we fit an ordinal logistic regression model to assess the association between the number of depressive symptoms at discharge and at last measurement (categorized as low, 0–3 symptoms, and high, 4–10 symptoms) and one-year outcomes.

The joint modeling analyses demonstrated that both subject-specific discharge CES-D measures and slope of CES-D measures over time were independently associated with one-year outcomes. The ordinal logistic regression model demonstrated that both the discharge and last CES-D measures were associated with one-year outcomes. (see Results) To explore these associations further, we classified patients into clinically relevant depressive symptom groups.

Depressive Symptom groups

Patients were classified into four all inclusive, mutually exclusive groups according to the number of depressive symptoms at hospital discharge and at final follow-up; final follow-up was 12 months after discharge for survivors, or at last CES-D measurement before death. Four or more depressive symptoms was defined as a “High” number of symptoms and 3 or fewer symptoms was defined as a “Low” number of symptoms. The four groups were:

patients with 3 or fewer depressive symptoms at discharge and follow-up (Low-Low); patients with 3 or fewer depressive symptoms at discharge and 4 or more symptoms at follow-up (Low-High); patients with 4 or more depressive symptoms at discharge and 3 or fewer symptoms at follow-up (High-Low); and patients with 4 or more depressive symptoms at discharge and follow-up (High-High). Unless otherwise noted, analyses and comparisons were made among patients in groups with 0–3 discharge depressive symptoms (Low-Low vs. Low-High) and, separately, among patients in groups with 4–10 depressive symptoms (High-High vs High-Low). Boxplots of CES-D scores over time were plotted. We used χ^2 tests for categorical variables and the Wilcoxon test statistic for continuous variables to examine differences in patient characteristics between depression symptom groups. The groups did not differ ($p>0.1$) in the proportions of patients in the intervention and usual care group in the original studies. We calculated logistic regression models to examine the association between patient characteristics and depressive groups. We used partial proportional odds models to examine the association between depressive symptom groups and the one-year outcome as the proportional odds assumption was not met for ADL and IADL dependencies. Partial proportional odds modeling[36] relaxes the proportional odds assumption of standard ordinal logistic regression modeling for some of the predictors. The partial proportional odds model included potential mediators such as discharge depressive symptoms, IADL and ADL dependencies at discharge, and a validated one year mortality risk index for hospitalized older adults[19]. We completed an additional analysis comparing one-year outcomes amongst all 4 groups and described all pairwise comparisons. Cox proportional hazards models were used to examine the association of subject-specific slopes and discharge depressive symptoms, and separately, depression groupings, with long-term mortality up to 10 years post-admission. The proportional hazards assumption was met for the covariates in these 10-year mortality models. The median survival time was 5.0 years (95% CI 4.4–5.4). Analyses were performed using SAS version 9.2 or Stata version 10.

RESULTS

The study cohort (Table 1) included 1129 patients with a mean age of 78.2 years; 66% were women, 22% African-American, and 44% were married. The most common comorbid conditions were congestive heart failure, chronic lung disease, diabetes mellitus, and peripheral vascular disease. On admission, most patients were independent in ADL and had 3 or fewer depression symptoms. One hundred thirty three patients (12%) died in the year after discharge. Of these, 19% died between 1 and 3 months, 30% died between 3 months and 6 months, and 51% died between 6 months and 12 months. An additional 733 (65%) patients died within 1 and 10 years after discharge.

Results of the joint mixed effects and ordinal logistic regression modeling demonstrated that both the number of depressive symptoms at discharge and the change in the number of depressive symptoms over time were independently associated with the one-year, hierarchical outcome of alive and independent, dependent in IADL and independent in ADL, dependent in ADL, or dead. The one-year outcome was associated with the number of depressive symptoms on discharge (OR 1.25; 95% CI, 1.18, 1.33; $P<0.001$) and with the subject-specific slopes of CESD scores after discharge (for each additional SD increase [equal to 0.5 additional symptom per year], OR, 1.26; 95% CI, 1.09, 1.46; $P= 0.002$).

Results were confirmatory in an ordinal logistic regression model of the one-year, hierarchical outcome of alive and independent, dependent in IADL and independent in ADL, dependent in ADL, or dead with discharge CES-D score and last CES-D score. The one-year outcome was independently associated with 4–10 depressive symptoms, compared to 0–3 depressive symptoms at discharge (OR, 1.5; 95% C.I., 1.2–1.8; $P=0.002$), and at last measurement (OR, 2.6; 95% C.I., 1.9–3.4; $P<0.001$).

In a proportional hazards model of 10-year mortality, the 10-year outcome was associated with the number of depressive symptoms at discharge (HR 1.11; 95% CI [1.07,1.15], P<0.001) and with the subject-specific slopes of CES-D scores from discharge to 1 year later (for each additional SD increase [equal to 0.5 additional symptom per year], HR 1.14; 95% CI [1.05, 1.25]; P= 0.003).

Characteristics of depressive symptom groups

Among the 719 patients with 0–3 depressive symptoms at discharge (Figure 1A), 643 (89%) had 0–3 symptoms one year later (the Low-Low group) and only 76 patients reported 4 –10 depressive symptoms one year later (the Low-High group). Among the 410 patients with 4–10 depressive symptoms at discharge (Figure 1B), 258 (63%) had 0–3 symptoms one year later (the High-Low group) and 152 reported 4–10 depressive symptoms (the High-High group).

Characteristics of patients in different depressive symptom groups

Among patients with 0–3 depressive symptoms at discharge, those in the Low-High group had more depressive symptoms on admission, and were more likely to live alone, have diabetes, or report fair or poor health, compared to patients in the Low-Low group (Table 2a); these differences remained significant in a multivariate logistic regression model. Among patients with 0–3 depressive symptoms at discharge, those without diabetes who live with an adult child, and report no depressive symptoms on admission and good general health, have a 96% probability of being in the Low-Low group and a 4% probability of being in the Low-High group.

Among patients with 4–10 depressive symptoms at discharge, those in the High-High group had more depressive symptoms on admission; fewer than 12 years education; and were dependent in more IADLs and ADLs at discharge compared to patients in the High-Low group (Table 2b). Among patients with 4–10 depressive symptoms at discharge, a married person with a high school education, three depressive symptoms on admission, and no IADL or ADL dependencies at discharge, has an 85% probability of being in the High-Low group and a 15% probability of being in the High-High group.

In other pairwise comparisons, patients in the Low-High group had higher prevalence of diabetes, fewer IADL dependencies at discharge, and lower admission CES-D scores, than patients in the High-High group, in a multivariate adjusted model. Patients in the Low-Low group had fewer IADL dependencies, and lower admission CES-D scores than those in the High-Low group.

Functional and mortality outcomes

More patients in the Low-High group were dependent in IADL or ADL or dead within one year of discharge (50% vs 33% in the Low-Low group, p=0.007) and this association remained significant (49% vs 37%, respectively, p=0.02) after adjusting for discharge depressive symptoms, discharge IADL and ADL function, and a one year mortality risk index (Table 3). More patients in the High-High group were dependent in IADL or ADL or dead within one year of discharge, (44% vs 16% in the High-Low group, p<0.001) and this association remained significant (39% vs 19%, respectively, p<0.001) after adjusting for discharge depressive symptoms, discharge IADL and ADL function, and a one year mortality risk index. For other pairwise comparisons, the Low-High group had worse outcomes compared to the High-Low group (p=0.02), the Low-High group had worse outcomes compared to the High-High group (p=0.05), the Low-Low group had similar outcomes to the High-Low group (p=0.78), and the Low-Low group had worse outcomes compared to the High-High group (p<0.001).

At 10 years, patients in the Low-High group were no more likely than patients in the Low-Low group to have died (77% vs 73%, respectively, p=0.15, hazard ratio (HR) = 1.2, 95% confidence interval (C.I.) =0.9–1.6) after adjusting for age, and discharge depressive symptoms, IADLs, and ADLs. At 10 years, patients in the High-High group had a higher risk of mortality (91% vs 79% in the High-Low group, p<0.0001, HR-1.7, 95% C.I.=1.3–2.1) after adjusting for age and discharge depression symptoms, IADLs, and ADLs.

DISCUSSION

We emphasize three findings from a one-year, longitudinal analysis of depressive symptoms in older patients discharged from the hospital. First, in repeated measures longitudinal analyses, both the number of depressive symptoms and the change in depressive symptoms over time were important clinical predictors of poor outcome. Second, in an exploratory analysis of clinically relevant depressive symptom groups, more than half of all patients were in the Low-Low group and nearly one quarter of all patients were in the High-Low group. Third, the Low-High and High-High groups had signs of preexisting vulnerability, such as more depressive symptoms on admission, worse general health or function, and living alone and had worse functional outcomes and survival, compared to the Low-Low and High-Low groups, respectively.

Only 7% of patients were in the Low-High group. Compared to the Low-Low group, the Low-High group was associated with signs of pre-existing vulnerability and worse one year functional outcomes and survival. This difference was moderate in size, statistically significant, robust across outcomes, and consistent in multivariate analyses, but did not extend to higher ten-year mortality. Our analyses did not determine whether increasing depressive symptoms preceded worsening ADL and IADL function, and it is possible that depressive symptoms are an epiphenomenon of poor or declining health.

Most patients with 4–10 depressive symptoms at discharge were in the High-Low group. The decline in symptoms occurred early, a finding also reported by Koenig et al.[37] The High-High group was associated with signs of preexisting vulnerability and had strikingly poor outcomes compared to the High-Low group; with 25% dying and only 16% independent in all ADLs and IADLs 1 year after discharge and higher risk for death at 10 years. Our findings are consistent with the hypothesis that depressive symptoms worsen outcomes. While function and depressive symptoms were measured concurrently, mortality was measured after the last depressive symptom measurement. Thus, the association of depressive symptoms with mortality indicates this is not simply a cross-sectional association. Previous studies have differed as to whether depressive symptoms in hospitalized patients are associated with mortality after discharge[11]. However, these studies did not determine whether symptoms persisted after discharge. We found worse outcomes in the Low-High group, compared to the Low-Low group, and in the High-High group compared to the High-Low group. Thus, persistent or increasing depressive symptoms are associated with worse outcomes.

The results of the joint modeling analysis and the association of worse functional and mortality outcomes in the High-High compared to the Low-High group support the intriguing possibility that the trajectory of depressive symptoms is important in determining functional and mortality outcomes. This was not seen in the comparison of the Low-Low and High-Low groups and this question should be a topic of further research.

Implications

Our study has several implications. First, most hospitalized older adults, even those with many depressive symptoms at discharge, report few depressive symptoms a year after

discharge. Second, assessment for depressive symptoms and other specific signs of vulnerability on admission and discharge can identify patients at increased risk for 4 or more depressive symptoms a year later. Third, patients in groups that reported an increasing or persistently high number of depressive symptoms after hospitalization were independently associated with worse functional outcomes and mortality after hospitalization, even when controlling for prognostic factors such as comorbid illness, severity of illness, and functional status. For those with persistent depressive symptoms, this association extended to increased mortality at 10 years, a finding also seen in hospitalized patients based on a single measure of depressive symptoms.[10] Although it is unclear whether the effects of depressive symptoms on health outcomes are direct or indirect, worsening or persistent depressive symptoms may have adverse physiologic effects,[38] reduce physical activity,[39] and decrease appropriate medical care. Thus, our findings provide a rationale for measuring depressive symptoms in hospitalized older adults, especially because they are often unrecognized.[40–42] Finally, physicians can use our findings to identify high-risk hospitalized older adults and to target them for intensive management. While previous interventions based on a single measurement of depressive symptoms have been disappointing,[43, 44] a recent intervention targeting hospitalized patients with persistent depressive symptoms has demonstrated promising results.[45]

Methodological Considerations

Several methodological considerations support the validity of our findings including, the large size of the cohort; the ability to evaluate potential confounders, such as comorbid illness, functional status, and cognitive status; use of a valid measure of depressive symptoms; and near complete ascertainment of outcomes

We recognize important limitations of our study. First, our findings may not apply to patients who were too sick to participate in the measurement of depressive symptoms at discharge or to surgical patients, who were not included in our study. Also, patients were recruited from two large urban hospitals and may not reflect patient populations in other settings. Second, we measured depressive symptoms and did not classify patients according to Diagnostic and Statistical Manual of Mental Disorders-IV (DSM-IV) diagnoses. We do not propose the use of the CES-D as a diagnostic instrument for depression,[23] but, the strong association of depressive symptoms, as measured with the CES-D, and poor outcomes demonstrated in this and other studies[46,47] highlight their importance. Third, antidepressant use after hospitalization was not measured and we are unable to determine the effect of antidepressant use on groups and outcomes. Fourth, hospital readmission and other clinical events occurring six or more months after hospitalization were not recorded. Thus, we cannot determine whether these influenced depressive symptom group. Fifth, our analyses had concurrent measurement of depressive symptoms and functional outcomes, so we could not determine the temporal relationship. However, the association of depressive symptoms with mortality indicates this is not simply a cross-sectional association. In community-dwelling older adults, Barry et al. demonstrated the temporal precedence of depressive symptoms and subsequent disability and failure to recover from disability.[48] Future work should assess the temporal sequence of these factors and also measure putative mediators such as physical activity and use of health care.

In conclusion, our results show that both the number of discharge depressive symptoms and the change in depressive symptoms after discharge are important in older adults discharged from the hospital. Patients who demonstrate persistently elevated or increasing depression symptoms have poor functional and mortality outcomes. Moreover, patients at high risk for developing persistently elevated or increasing depression symptoms can be identified based on clinical features at admission. These results provide a rationale to monitor depressive

symptoms during and after hospitalization and demonstrate a need for interventions that can reduce symptoms and improve function and survival among at-risk patients.

Acknowledgments

Presented in part at the annual meeting of the Society of General Internal Medicine, May 2009, Miami, Florida

Funding: This work was supported by the National Institute on Aging RO1 AG029233 and a grant from the S.D. Bechtel, Jr. Foundation (PI: Dr. Landefeld). Dr. Mehta was supported by a Research Career Scientist Award from the National Institute on Aging (NIA-K-01AG025444). She was an affiliate of the Center for Aging in Diverse Communities at UCSF, a part of the P30 AG 15272 350 Resource Centers for Minority Aging Research Program (NIA, National Institute of Nursing Research (NIN), and the National Center for Minority Health and Health Disparities). Dr. Pierluissi was supported by an administrative supplement to the NIA RO1 AG029233. The Acute Care for Elders (ACE) studies were supported by grants from the John A. Hartford Foundation (88277-3G and 2006-0108), the National Institute on Aging (AG-10418-03), and the Summa Health System Foundation.

REFERENCES

1. Koenig HG, Meador KG, Cohen HJ, et al. Depression in elderly hospitalized patients with medical illness. Arch Intern Med. 1988; 148:1929–1936. [PubMed: 3415405]
2. Bula CJ, Wietlisbach V, Burnand B, et al. Depressive symptoms as a predictor of 6-month outcomes and services utilization in elderly medical inpatients. Arch Intern Med. 161:2609–2615. 20016. [PubMed: 11718593]
3. Covinsky KE, Kahana E, Chin MH, et al. Depressive symptoms and 3-year mortality in older hospitalized medical patients. Arch Intern Med. 1999; 130:563–569.
4. Ng TP, Niti M, Tan WC, et al. Depressive symptoms and chronic obstructive pulmonary disease: Effect on mortality, hospital readmission, symptom burden, functional status, and quality of life. Arch Intern Med. 2007; 167:60–67. [PubMed: 17210879]
5. Parashar S, Rumsfeld JS, Spertus JA, et al. Time course of depression and outcome of myocardial infarction. Arch Intern Med. 2006; 166:2035–2043. [PubMed: 17030839]
6. Covinsky KE, Fortinsky RH, Palmer RM, et al. Relation between symptoms of depression and health status outcomes in acutely ill hospitalized older persons. Ann Intern Med. 1997; 126:417–425. [PubMed: 9072926]
7. McCusker J, Latimer E, Cole M, et al. Major depression among medically ill elders contributes to sustained poor mental health in their informal caregivers. Age Ageing. 2007; 36:400–406. [PubMed: 17537745]
8. Jiang W, Alexander J, Christopher E, et al. Relationship of depression to increased risk of mortality and rehospitalization in patients with congestive heart failure. Arch Intern Med. 2001; 161:1849–1856. [PubMed: 11493126]
9. Jiang W, Kuchibhatla M, Clary GL, et al. Relationship between depressive symptoms and long-term mortality in patients with heart failure. Am Heart Journal. 2007; 154:102–108. [PubMed: 17584561]
10. Koenig HG, George LK, Larson DB, et al. Depressive symptoms and nine-year survival of 1,001 male veterans hospitalized with medical illness. Am J Geriatr Psychiatry. 1999; 7:124–131. [PubMed: 10322239]
11. Cole MG. Does depression in older medical inpatients predict mortality? A systematic review. Gen Hosp Psychiatry. 2007; 29:425–430. [PubMed: 17888809]
12. Fulop G, Strain JJ, Stettin G. Congestive heart failure and depression in older adults: Clinical course and health services use 6 months after hospitalization. Psychosomatics. 2003; 44:367–373. [PubMed: 12954910]
13. Koenig HG, Shelp F, Goli V, et al. Survival and health care utilization in elderly medical inpatients with major depression. J Am Geriatr Soc. 1989; 37:599–606. [PubMed: 2738278]
14. Kurdyak PA, Gnam WH, Goering P, et al. The relationship between depressive symptoms, health service consumption, and prognosis after acute myocardial infarction: A prospective cohort study. BMC Health Serv Res. 2008; 8:200. [PubMed: 18826611]

15. Andreescu C, Chang CC, Mulsant BH, et al. Twelve-year depressive symptom trajectories and their predictors in a community sample of older adults. Int Psychogeriatr / IPA. 2008; 20:221–236.
16. Cui X, Lyness JM, W Tang, et al. Outcomes and predictors of late-life depression trajectories in older primary care patients. Am J Geriatr Psychiatry. 2008; 16:406–415. [PubMed: 18448851]
17. McCusker J, Cole M, Ciampi A, et al. Twelve-month course of depressive symptoms in older medical inpatients. Int J Geriatr Psychiatry. 2007; 22:411–417. [PubMed: 17096457]
18. Counsell SR, Holder CM, Liebenauer LL, et al. Effects of a multicomponent intervention on functional outcomes and process of care in hospitalized older patients: A randomized controlled trial of Acute Care for Elders (ACE) in a community hospital. J Am Geriatr Soc. 2000; 48:1572–1581.
19. Walter LC, Brand RJ, Counsell SR, et al. Development and validation of a prognostic index for 1-year mortality in older adults after hospitalization. JAMA. 2001; 285:2987–2994. [PubMed: 11410097]
20. Knaus WA, Draper EA, Wagner DP, et al. APACHE II: A severity of disease classification system. Crit Care Med. 1985; 13:818–829. [PubMed: 3928249]
21. Irwin M, Artin KH, Oxman MN. Screening for depression in the older adult: Criterion validity of the 10-item Center for Epidemiological Studies Depression Scale (CES-D). Arch Intern Med. 1999; 159:1701–1704. [PubMed: 10448771]
22. McKhann GM, Borowicz LM, Goldsborough MA, et al. Depression and cognitive decline after coronary artery bypass grafting. Lancet. 1997; 349:1282–1284. [PubMed: 9142062]
23. Schein RL, Koenig HG. The Center for Epidemiological Studies-Depression (CES-D) Scale: assessment of depression in the medically ill elderly. Int J Geriatr Psychiatry. 1997; 12:436–446. [PubMed: 9178047]
24. Jones BL, Nagin DS. Advances in group-based trajectory modeling and procedure for estimating them. Sociol Meth Res. 2007; 35:542–571.
25. Cnaan A, Laird NM, Slasor P. Using the general linear mixed model to analyse unbalanced repeated measures and longitudinal data. Stat Med. 1997; 16:2349–2380. [PubMed: 9351170]
26. Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis. 1987; 40:373–383. [PubMed: 3558716]
27. Boyd CM, Landefeld CS, Counsell SR, et al. Recovery of activities of daily living in older adults after hospitalization for acute medical illness. J Am Geriatr Soc. 2008; 56:2171–2179. [PubMed: 19093915]
28. Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc. 1975; 23:433–441. [PubMed: 1159263]
29. Katz S, Ford AB, Moskowitz RW, et al. Studies of illness in the aged: the index of ADL: A standarized measure of biological and psychosocial function. JAMA. 1963; 185:914–919. [PubMed: 14044222]
30. Lawton MP, Brody EM. Assessment of older people: Self-maintaining and instrumental activities of daily living. Gerontologist. 1969; 9:179–186. [PubMed: 5349366]
31. Idler EL, Kasl SV. Self-ratings of health: Do they also predict change in functional ability? J Gerontol B Psychol Sci Soc Sci. 1995; 50:S344–353. [PubMed: 7583813]
32. Rich-Edwards JW, Corsano KA, Stampfer MJ. Test of the National Death Index and Equifax Nationwide Death Search. Am J Epidemiol. 1994; 140:1016–1019. [PubMed: 7985649]
33. Royston P. Multiple imputation of missing values: update. Stata J. 2004; 5:188–201.
34. Carlin JB, Royston P. A new framework for managing and analyzing multiply imputed data in Stata. Stata J. 2008; 8:49–67.
35. Li E, Wang N, Wang N. Joint Models for a Primary Endpoint and Multiple Longitudinal Covariate Processes. Biometrics. 2007; 63:1068–1078. [PubMed: 17501940]
36. Williams R. Generalized ordered logit/partial proportional odds models for ordinal dependent variables. Stata J. 2006; 6:58–82.

37. Koenig HG, George LK, Peterson BL, et al. Depression in medically ill hospitalized older adults: Prevalence, characteristics, and course of symptoms according to six diagnostic schemes. Am J Psychiatry. 1997; 154:1376–1383. [PubMed: 9326819]
38. Wulsin LR, Musselman D, Otte C, et al. Depression and whole blood serotonin in patients with coronary heart disease from the Heart and Soul Study. Psychosom Med. 2009; 71:260–265. [PubMed: 19297311]
39. Whooley MA, de Jonge P, Vittinghoff E, et al. Depressive symptoms, health behaviors, and risk of cardiovascular events in patients with coronary heart disease. JAMA. 2008; 300:2379–2388. [PubMed: 19033588]
40. Cepoiu M, McCusker J, Cole MG, et al. Recognition of depression in older medical inpatients. J Gen Intern Med. 2007; 22:559–564. [PubMed: 17443361]
41. McCusker J, Cole M, Latimer E, et al. Recognition of depression in older medical inpatients discharged to ambulatory care settings: A longitudinal study. Gen Hosp Psychiatry. 2008; 30:245–251. [PubMed: 18433656]
42. Amin AA, Jones AM, Nugent K, et al. The prevalence of unrecognized depression in patients with acute coronary syndrome. Am Heart J. 2006; 152:928–934. [PubMed: 17070162]
43. Cole MG, Elie LM, McCusker J, et al. Feasibility and effectiveness of treatments for depression in elderly medical inpatients: A systematic review. Int Psychogeriatr / IPA. 2000; 12:453–461.
44. Cole MG, McCusker J, Elie M, et al. Systematic detection and multidisciplinary care of depression in older medical inpatients: A randomized trial. CMAJ. 2006; 174:38–44. [PubMed: 16330624]
45. Davidson KW, Rieckmann N, Clemow L, et al. Enhanced depression care for patients with acute coronary syndrome and persistent depressive symptoms: Coronary psychosocial evaluation studies randomized controlled trial. Arch Intern Med. 2010; 170:600–608. [PubMed: 20386003]
46. Barry LC, Allore HG, Bruce ML, et al. Longitudinal association between depressive symptoms and disability burden among older persons. J Gerontol A Biol Sci Med Sci. 2009; 64:1325–1332. [PubMed: 19776217]
47. Barry LC, Allore HG, Guo Z, et al. Higher burden of depression among older women: The effect of onset, persistence, and mortality over time. Arch Gen Psychiatry. 2008; 65:172–178. [PubMed: 18250255]
48. Barry LC, Murphy TE, Gill TM. Depression and functional recovery after a disabling hospitalization in older persons. J Am Geriatr Soc. 2011; 59:1320–1325. [PubMed: 21668916]

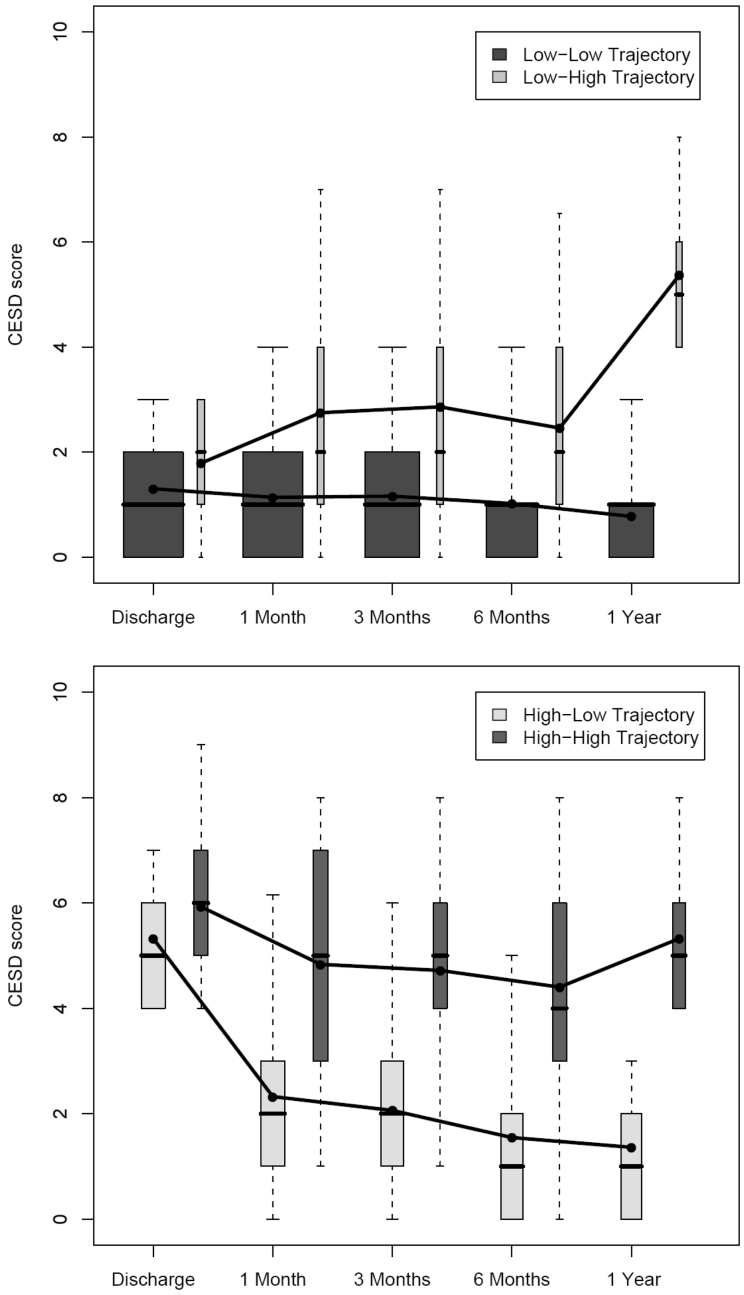

Figure 1. Depressive Symptom Group during study follow-up

The top panel represents patients with 0–3 depression symptoms at discharge (n=719). The bottom panel represents patients with 4–10 depression symptoms at hospital discharge (n=410). Data shown are actual means (dots) and medians (horizontal bars) of Center for Epidemiologic Studies Depression (CESD) Scale symptoms over time. The mean number of depressive symptoms for the Low-Low group are 1.30, 1.14, 1.16, 1.02, and 0.77; for the Low-High group, 1.79, 2.75, 2.86, 2.46, 5.37; for the High-High group, 5.92, 4.84, 4.72, 4.40, and 5.32; and for the High-Low group, 5.32, 2.33, 2.06, 1.55, and 1.36,, at discharge, 1 month, 3 months, 6months, and 1 year, respectively. Boxes represent the interquartile range of the number of depressive symptoms for each group over time. The width of each box is

proportional to the number of patients. Vertical dashed lines represent the range of values encompassing 5% to 95% of depressive symptoms for each group over time.

Table 1

Patient Characteristics* (N=1129)

Sociodemographic	n (col %) or Mean (SD)†
Age in years, Mean ± SD	78.2 ± 5.9
Women	744 (66)
Race	
Non-White	243 (22)
Marital Status	
Married	494 (44)
Widowed	158 (14)
Education, yr	
<12 years	415 (38)
Lives alone	459 (41)
Comorbidity/Impairments	
Comorbid conditions	
Congestive Heart Failure	289 (26)
Chronic Lung Disease	265 (24)
Diabetes	207 (18)
Peripheral Vascular Disease	205 (18)
Cerebrovascular Disease	164 (15)
Past Myocardial Infarction	162 (14)
Metastatic Cancer	27 (2)
Charlson Comorbidity Score, Mean ± SD	1.9 ± 1.8
Serum Albumin in g/dl, Mean ± SD	3.6 ± 0.6
Acute Physiology Score, Mean ± SD	9.7 ± 3.1
Function	
Admission	
IADL	
0–2 dependencies	516 (46)
3+ dependencies	607 (54)
ADL	
0 dependencies	608 (54)
1 dependency	176 (16)
2+ dependencies	340 (30)
Cognitive function	
Normal	873 (78)
Discharge	
IADL	
0–2 dependencies	715 (63)
3+ dependencies	414 (37)
ADL	
0 dependencies	759 (67)

Sociodemographic	n (col %) or Mean (SD)†
1 dependency	170 (15)
2+ dependencies	200 (18)
Depression symptoms	
Admission	
Mild (0–3)	735 (65)
Moderate (4–6)	282 (25)
Severe (7–10)	112 (10)
Discharge	
Mild (0–3)	719 (64)
Moderate (4–6)	305 (27)
Severe (7–10)	105 (9)
Self rated health	
Poor/Fair	358 (46)
Good/Very Good/ Excellent	601 (53)

*Data were missing for the following characteristics: education (n=42); living alone (n=13); comorbid conditions (n=6); Charlson comorbidity score (n=6); Acute Physiology Score (n=3); albumin (n=116); admission Instrumental activity of daily living (IADL)(n=6); admission Activity of daily living (ADL)(n=5); admission cognitive function (n=3); self rated health (n=170).

†some percents do not add to 100% due to rounding

Table 2a

Characteristics of Patients with **0–3** Depressive Symptoms at Hospital Discharge according to Group and Comparisons between Groups *

Characteristics, (col % or mean (SD)	Low-Low Group n=643	Low-High Group n=76	Unadjusted bivariate p-values	Adjusted Multivariate results OR (95% CI) †
Sociodemographic				
Age in years, Mean ± SD	77.7 ± 58	78.5 ± 6.3	0.38	
Women	65	74	0.11	
Race			0.41	
Non-White	23	18		
Marital status			0.19	
Married	47	36		
Education			0.71	
≥ 12 years	62	66		
Lives alone	37	51	0.02	1.8 (1.1–3.0)
Comorbidity/Impairments				
Comorbid conditions				
Diabetes	19	32	0.01	1.8 (1.1–3.1)
Charlson Comorbidity Score, Mean ± SD	1.8 ± 1.8	2.3 ± 2.0	0.05	
Serum Albumin in g/dl, Mean ± SD	3.6 ± 0.5	3.5 ± 0.5	0.22	
Acute Physiology Score, Mean ± SD	9.4 ± 3.0	10.1 ± 3.3	0.09	
Function				
Admission				
Cognitive function			0.96	
Normal	80	80		
Discharge				
IADL, Mean SD	1.5 ± 1.8	1.8 ± 1.9	0.15	
ADL, Mean SD	0.5 ± 1.1	0.7 ± 1.1	0.13	
Depression Symptoms				
Admission CESD Score	1.9 ± 1.9	2.9 ± 2.5	<0.0001	1.2 (1.1–1.4)
Self rated health				
Poor/Fair	26	46	<0.001	2.0 (1.2–3.4)
Intervention Group			0.69	
Usual Care	48	50		

* IADL=instrumental activity of daily living, ADL=Activity of Daily Living, CESD = Center for Epidemiologic Studies Depression Scale-10.

† The variables that were significant at p<0.05 were used in the multivariate logistic regression model. The Low-Low Group is the referent group.

Table 2b

Characteristics of Patients with **4–10** Depressive Symptoms at Hospital Discharge according to Group and Comparisons between Groups *

Characteristics, n (col %)	High-Low Group n=258	High-High Group n=152	Unadjusted bivariate p-values	Audjusted Multivariate results OR (95% CI) †
Sociodemographic				
Age in years, Mean ± SD	78.7 ± 6.0	78.8 ±5.6	0.82	
Women	61	76	<0.01	1.2 (0.7–2.0)
Race			0.08	
Non-White	18	25		
Marital status			0.01	0.6 (0.4–1.1)
Married	42	28		
Education			0.04	0.6 (0.4–0.9)
≥ 12 years	62	66		
Lives alone	40	51	0.04	1.1 (0.7–1.9)
Comorbidity/Impairments				
Comorbid conditions				
Diabetes	15	15	0.96	
Comorbidity Score, Mean ± SD	1.8 ± 1.7	1.9 ± 1.6	0.45	
Serum Albumin in g/dl, Mean ± SD	3.5 ± 0.6	3.6 ± 0.6	0.12	
Acute Physiology Score, Mean ± SD	10.0 ± 3.3	10.2 ± 3.0	0.34	
Function				
Admission				
Cognitive function			0.97	
Normal	74	74		
Discharge				
IADL, Mean SD	2.4 ± 2.0	3.3 ± 2.1	<0.0001	1.1 (1.0–1.2)
ADL, Mean SD	0.8 ± 1.4	1.4 ± 1.6	<0.0001	1.2 (1.0–1.4)
Depression Symptoms				
Admission CESD Score	3.6 ± 2.4	5.1 ± 2.6	<0.0001	1.3 (1.2–1.4)
Self rated health				
Poor/Fair	40	56	<0.01	1.2 (0.7–1.9)
Intervention Group			0.59	
Usual Care	51	45		

* IADL=instrumental activity of daily living, ADL=Activity of Daily Living, CESD = Center for Epidemiologic Studies Depression Scale-10.

† The variables that were significant at p<0.05 were used in the multivariate logistic regression model. High-Low group is the referent group.

J Am Geriatr Soc. Author manuscript; available in PMC 2013 December 01.

Table 3

Functional and 1 Year Mortality Outcomes by Group (N=1129)

	Alive Independe nt	Alive Dependent in IADL Independent in ADL	Alive Dependent in ADL	Dead	p-value*
0–3 Depression Symptoms at Discharge					
Bivariate Analyses		Unadjusted Percents			
Low-Low Group (n=643)	50%	22%	20%	8%	
Low-High Group (n=76)	33	28	26	13	0.007
Multivariate Analyses, adjusting for Discharge characteristics†		Adjusted Predicted Probabilities			
Low-Low Group (n=643)	0.49	0.27	0.19	0.06	
Low-High Group (n=76)	0.37	0.28	0.26	0.09	0.02
4 –10 Depression Symptoms at Discharge					
Bivariate Analyses		Unadjusted Percents			
High-Low Group (n=258)	44%	24%	20%	12%	
High-High Group (n=152)	16	20	38	25	<0.001
Multivariate Analyses, adjusting for Discharge characteristics†		Adjusted Predicted Probabilities			
High-Low Group (n=258)	0.39	0.29	0.24	0.09	
High-High Group (n=152)	0.19	0.24	0.36	0.21	<0.0001

*P-value for association of low-low vs low-high and high-low vs high-high, respectively with ordinal outcome in a partial proportional odds model. P-value for association of all 4 groups with ordinal outcome in an adjusted partial proportional odds model is <0.001.

†Discharge characteristics included in the partial proportional odds models were depression symptoms, ADL and IADL dependencies, intervention group, and one-year post-hospitalization mortality risk index. This index uses the following point scoring system: male sex-1 point, 1–4 ADL dependencies-2 points, 5 ADL dependencies-5 points; presence of congestive heart failure-2 points, cancer-3 points, metastatic cancer-8points; creatinine >3.0 mg/dl-2 points; albumin between 3.0–3.4 g/dl-1 point and <3.0 g/dl-2 points.