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Functional Impairment and Hospital Readmission in Medicare Seniors

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Abstract

Importance—Medicare currently penalizes hospitals for high rates of readmission for seniors but does not account for common age-related syndromes such as functional impairment.

Objectives—Given the high prevalence of functional impairments in community-dwelling seniors, we assessed effects of functional impairment on Medicare hospital readmissions.

Study Design, Participants, and Setting—We created a nationally-representative cohort of 7,854 community-dwelling seniors in the Health and Retirement Study (HRS) with 22,289 Medicare hospitalizations from 2000–2010.

Main Outcome and Measurements—Outcome was 30-day readmission, assessed by Medicare claims. Main predictor was functional impairment determined from HRS interview preceding hospitalization, stratified into 5 levels: no functional impairments, difficulty with 1 instrumental activity of daily living (IADL), difficulty with 1 activity of daily living (ADL), dependency (need for help) in 1–2 ADLs, and dependency in 3 ADLs. Adjustment variables included age, race, gender, income, and net worth and comorbid conditions (Elixhauser score from Medicare claims), and prior admission. We performed multivariable logistic regression adjusted

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The first author (SRG) had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Disclosures:

The authors have no conflicts of interest to declare relative to this study.

Author Contributions:

S.R. Greysen: study conception and design, analysis and interpretation of data; drafting and revising of manuscript; final approval of manuscript for publication.

I.S. Cenzer: data interpretation; manuscript revision; final approval for publication.

A. D. Auerbach: study conception, data interpretation; manuscript revision; final approval for publication.

K.E. Covinsky: study conception and design, analysis and interpretation of data; revising of manuscript; final approval of manuscript for publication.

for clustering at patient level to characterize the association of functional impairments and readmission.

Results—Mean age 79 (± 8 ; 65–105), 58% female, 85% White, 90% reported ≥ 3 comorbidities, 86% had ≥ 1 hospitalization in previous year. Overall, 48% had some level of functional impairment prior to admission and 15% experienced a 30-day readmission. We found a progressive increase in adjusted risk of readmission as the degree of functional impairment increased: 13.5% with no functional impairment, 14.3% with ≥ 1 IADL difficulty (OR 1.06; 95% CI 0.94–1.20), 14.4% with ≥ 1 ADL difficulty (OR 1.08; 0.96–1.21), 16.5% with dependency in ≥ 2 ADLs (OR 1.26; 1.11–1.44), and 18.2% with dependency in ≥ 3 ADLs (1.42; 1.20–1.69). Sub-analysis restricted to patients admitted with conditions targeted by Medicare (heart failure, myocardial infarction, and pneumonia) revealed a parallel trend with larger effects for the most-impaired (16.9% readmission rate for no impairment vs. 25.7% for dependency in ≥ 3 ADLs, OR 1.70; 1.04–2.78).

Conclusions—Functional impairment is associated with increased risk of 30-day, all-cause hospital readmission in Medicare seniors, especially those admitted for heart failure, myocardial infarction or pneumonia. Functional impairment on admission may be an overlooked but highly suitable target for interventions to reduce Medicare hospital readmissions.

Relevance—Functional impairment may be an important but under-addressed factor in preventing readmissions for Medicare seniors.

Keywords

readmissions; Medicare; functional impairments; Health and Retirement Study

BACKGROUND

Unplanned hospital readmission affects 15–30% of Medicare patients with costs exceeding \$17 billion annually.¹ Accordingly, the Centers for Medicare and Medicaid Services (CMS) and others have called for focused efforts to reduce hospital readmission rates.^{2,3,4} The implementation of a controversial CMS Hospital Readmission Reduction Program (HRRP) in 2012 as a core quality-improvement and cost-savings component of the Affordable Care Act underscores the importance of this issue in national healthcare policy.^{5,6} Despite intense efforts, predicting readmission risk remains imprecise⁷ and growing evidence suggests that unmeasured patient-related factors may be at the heart of variations in hospital readmission rates.⁸ Ironically, while over 80% of Medicare's 50 million beneficiaries are 65 or older,⁹ the impact of common, patient-level geriatric conditions such as functional impairment on readmission has not been extensively explored.

Functional impairment is highly prevalent in community-dwelling Medicare beneficiaries and associations with acute care utilization and mortality are well known.^{10,11} Acute illness has profound effects on functional status in older adults, thus impairment is even more common for hospitalized adults.^{12,13} Functional status has also been linked to important outcomes for hospitalized, older adults such as nursing home placement or death within one year,^{14,15} however, few studies have examined the role of functional impairment on readmission specifically. Existing studies have suggested a relationship but are limited by

single-site data, short duration of follow up, or small sample size which cannot be reliably extrapolated broadly to the entire Medicare population.^{16,17, 18} Functional impairment has also been hypothesized to play a key role in “post-hospitalization syndrome” that may predispose older, vulnerable adults to readmission.¹⁹ Unfortunately, previous high-quality readmission studies which rely on Medicare data have been unable to assess the effects of functional impairment because functional status of hospitalized Medicare beneficiaries is not reported to CMS.^{20,21}

To address these gaps in the literature, we utilized longitudinal, nationally-representative survey data from the Health and Retirement Study (HRS) which includes functional assessments of community-dwelling Medicare beneficiaries linked to Medicare claims from 2000–2010. We applied criteria used in the current CMS readmission penalty and examined the effects of functional impairments on 30 day hospital readmission. We hypothesized that functional impairment would be associated with 30 day readmission and that severity of impairment would be correlated with higher odds for readmission. Greater understanding of functional vulnerability is crucial to improving transitions of care and increasing attention to often-overlooked functional issues for older adults in light of the new Medicare HRRP policy.

METHODS

Participants

The Health and Retirement Study (HRS) was designed to examine changes in health and wealth as people age.^{22,23} HRS is an ongoing nationally-representative longitudinal study of participants age 50 and older with follow up surveys administered to all participants in waves every 2 years; response rates range from 80–90% and over 85% of participants agree to have their responses linked to their Medicare claims data. The study started in 1992 and new community-dwelling participants are recruited every six years to remain representative of the aging US population. If a participant is not able to complete an interview, the interview is conducted with a proxy respondent (between 6.8–11.2% interviews were conducted by proxies in 2000–2008 waves). Detailed information on steps taken by HRS to recruit and maintain a representative sample of older, community-dwelling adults is described in a series of HRS methods papers available on the HRS website.^{24, 25}

We created a cohort of community-dwelling participants age 65 or older and admitted to a hospital between January 1, 2000 and December 31, 2010. We included participants who enrolled in HRS after 2000 provided they were age 65 or older. Similarly, patients who were already enrolled in HRS in 2000 but were not yet 65 were included in the cohort once they reached age 65. To identify hospital admissions, we linked HRS survey data to Medicare claims and searched for inpatient claims in Medicare files. Out of 16,719 participants with their HRS surveys linked to Medicare claims, 10,146 (61%) were admitted to an eligible hospital (acute care hospitals only; no rehabilitation or PPS-exempt cancer hospitals) at least once during the sampling frame resulting in 31,289 unique admissions. Following CMS policy for the HRRP, we excluded admissions for the following reasons: 1. Transition to HMO plan within 30 days of discharge as the CMS readmission penalty does not apply to managed care admissions (2,680, 8.5%); 2. Death in hospital or within 30 days of discharge

(2,400, 7.6%); 3. Transfer to another acute care facility before discharge (1,125, 3.6%); 4. Less than 12 months of Medicare claims prior to admission required to determine comorbidities from ICD-9 codes (854, 2.7%); 5. discharge Against Medical Advice (57, <1%). We also excluded participants with no HRS interview within the preceding 2 survey waves (1,874, 5.9%) resulting in a final sample of 22,289 admissions from 7,854 participants.

Measures

Primary Predictor: functional impairment—We employed two widely-used measures of functional impairment: Activities of Daily Living (ADL) and Instrumental ADL (IADL). Both measures were obtained from the HRS interview immediately preceding hospital admission. The ADL are a series of self-care activities essential to living independently in the community^{26,27,28} which include bathing, dressing, transferring, toileting, and eating. The IADL require higher levels of functioning and difficulties often signal a need for ongoing care from family members or health providers.²⁹ For IADLs we used taking medications as prescribed, managing finances, shopping for groceries or clothing, preparing meals, telephone use, and transportation within the community. For both ADL and IADL, we operationalized responses into binary variables with those reporting any ADL or IADL difficulty vs. those reporting no difficulties. Difficulty in any ADL or IADL implies the task is burdensome but can be accomplished without assistance from another person. Additionally, for ADL, we created an ordinal, 3-level variable: no dependencies, 1–2 dependencies, and 3 ADL dependencies. Dependency in any ADL implies the individual cannot accomplish that task without assistance from another person. We created an ordinal, 5-level classification to integrate IADL and ADL difficulty and dependency as predictors of readmission: we classified subjects as having no functional impairments, difficulty with 1 instrumental activity of daily living (IADL), difficulty with 1 activity of daily living (ADL), dependency in 1–2 ADLs, and dependency in 3 ADLs. This 5-level classification reflects the clinical continuum of functional status and typical natural history of impairment in which individuals sequentially develop IADL difficulty, then ADL difficulty, then 1 or 2 ADL dependencies, and ultimately multiple ADL dependencies.³⁰

Main Outcome: 30-day readmission—We used CMS data to identify date of discharge for each index admission; those with another admission within 30 days were classified as a readmission. Overall, 15% of hospitalizations were followed by a 30-day readmission representing 3,457 readmissions (2,343 individuals).

Other Measurements—We considered health and demographic factors shown to impact 30-day readmission in prior studies that could introduce confounding into our analyses. Demographic factors included age, gender, race and/or ethnicity, marital status, education, income and wealth. Health factors included the Elixhauser comorbidity score calculated from ICD-9 codes and any hospitalization within one year prior to the index admission. Income was measured by asking the subject to report their total household income in the previous calendar year. Net worth was measured by asking the subject to report their total assets and debts. Comorbidities for the Elixhauser score and age were determined from

Medicare hospital claims data at the time of index admission. All other data above was derived from the HRS survey immediately preceding hospitalization.

Statistical Analysis

We analyzed our cohort of hospitalized Medicare seniors to determine effects of functional impairment on all-cause hospital readmission within 30 days. Given multiple admissions per HRS participant, we used admissions rather than individual participants as our unit of analysis. This analytical decision also reflects the clinical reality that many older adults face multiple admissions over time and mirrors CMS-HRRP as well. We used logistic regression with robust variance estimation (i.e. sandwich estimator) to adjust for clustering of admissions within individuals. Regressions do not account for the complex survey design of HRS, but do adjust for the differential probability of selection and for clustering of admissions at the patient level. This adjustment was performed by using the cluster option to the appropriately weighted logistic regression command in Stata 12.

Table 1 describes distributions of each risk factor among those re-admitted and not re-admitted within 30 days of index admission. We tested the difference in distribution using Chi Square tests for binary and categorical variables and t-test for continuous variables, accounting for differential probability of selection and the complex sampling design of the HRS. Next, using readmission within 30 days as a dichotomous variable, we examined the relationship between functional status and readmission using unadjusted and adjusted logistic regression. We used multivariate logistic regression to adjust outcomes for all demographic and health risk factors described above. We also performed a test of trend to examine whether overall increasing levels of functional impairment across levels was associated with overall increasing risk of readmission. To determine whether longer time from functional measurement and index admission might influence results, we also performed a sensitivity analysis limited to admissions with functional measurements taken within the preceding 6 months. Since hospitals and CMS focus on rates (rather than odds ratios) for readmission, we also used the same adjustor variables to model predicted readmission rates (predicted probability). Finally, to maximize alignment of our analyses with current the current Medicare HRRP, we performed a sub-analysis restricted to hospital admissions for 3 diagnoses targeted by the HRRP: heart failure, myocardial infarction, and pneumonia.

RESULTS

As shown in Table 1, complete data were available for 22,289 hospital admissions (7,854 participants). Ages ranged from 65–105 (mean 78.7, ± 7.7); 58% were female, 85% were White, 90% reported 3 comorbidities, and 86% had 1 hospitalization in the year preceding their index hospital admission. Overall 15% of hospital admissions had a readmission within 30 days. Several patient characteristics differed significantly for admissions with a readmission versus those without: Non-White race/ethnicity (17% vs. 15%), annual income (\$21,000 vs. \$24,000), net wealth (\$103,000 vs. \$137,000), less than high school education (35% vs. 32%), fair or poor self-rated health (56% vs. 50%), number

of Elixhauser comorbidities (7.2 vs. 5.7), and 1 or more hospitalization in the year prior to index admission (81% vs. 87%).

Overall, 48% had some level of functional impairment prior to admission (Table 1). In multivariable regression analysis, we found a progressive increase in adjusted risk of readmission as the degree of functional impairment increased (test for trend $p < 0.001$): 13.5% with no functional impairment, 14.3% with 1 IADL difficulty (OR 1.06; 95% CI 0.94–1.20), 14.4% with 1 ADL difficulty (OR 1.08; 0.96–1.21), 16.5% with dependency in 1–2 ADLs (OR 1.26; 1.11–1.44), and 18.2% with dependency in 3 ADLs (OR 1.42; 1.20–1.69). See Table 2. Results from a sensitivity analysis limited to those admissions with functional measurements taken within the preceding 6 months were not significantly different from the unrestricted analysis.

In sub-analysis restricted to patients admitted with conditions targeted by the current Medicare HRRP (heart failure, myocardial infarction, and pneumonia), 19% of admissions were associated with a 30-day readmission. Multivariable regression revealed a trend similar to the full sample with respect to rising odds of readmission with increasing impairment. Rates of readmission were higher in each category of impairment but effect sizes were similar to the full sample except for the most-impaired category (Table 3): 16.9% with no functional impairment, 16.5% with 1 IADL difficulty (OR 0.97; 95% CI 0.66–1.44), 18.8% with 1 ADL difficulty (OR 1.14; 0.82–1.58), 18.4% with dependency in 1–2 ADLs (OR 1.11; 0.77–1.61), and 25.7% for dependency in 3 ADLs (OR 1.70; 1.04–2.78).

COMMENT

In this 10-year longitudinal, nationally-representative study of hospital admissions among Medicare seniors, approximately half (48%) had functional impairments which are associated with higher readmission rates. Additionally, the risk of readmission increased in a dose-response fashion as the severity of impairment increased: the most functionally-impaired patients were 42% more likely to be readmitted compared to those with no impairments. Despite the prevalence of these impairments and well-known associations with outcomes of care in this population, functional status has been overlooked in current analyses of readmission. A recent systematic review of readmission risk prediction models found that only 2 out of 30 high-quality studies included functional status as a predictor or adjustment variable.⁷ Thus, unmeasured functional impairments may play a key mechanistic role in what has been described as “post-hospitalization syndrome” – a condition of elevated, generalized risk for poor health outcomes within 30 days of discharge due to patients’ inability to care for themselves, manage their affairs, and recover from their hospitalization that leads to readmission shortly after discharge.¹⁹ Our findings suggest this condition of generalized risk may be rooted in pre-hospitalization functional impairments. Our findings also build on smaller or single-site studies showing a consistent relationship between functional impairment and readmission.^{13, 16, 17, 18}

This association between functional impairment and readmission has important policy and financial implications for hospitals. The difference in readmissions rates we demonstrate, while modest in absolute terms (10% difference between unimpaired and the most-

impaired), can translate to very substantial penalties for individual hospitals under the new CMS readmission reduction program. In 2014, hospitals with unplanned readmission rates a few percentage points above the “expected rate” calculated by the CMS readmission policy can face annual reimbursement penalties up to 2% (up to 3% in 2015) which may represent the majority of operating budget margins for many hospitals. In 2013 alone, 2,225 hospitals (66% of eligible US hospitals) were penalized for excess readmissions under the new HRRP resulting in a total of \$227 million in withheld reimbursements.³¹ In our sub-analyses restricted to patients with index admission diagnoses targeted by the current CMS policy (heart failure, heart attack, or pneumonia), the effects were even larger among the most functionally-impaired: those with 3 or more ADL dependencies were 70% more likely to be readmitted than those with no impairments. These sub-analysis findings modeled after the current scope of the Medicare readmission policy suggest that functional impairments may already have financial implications for U.S. hospitals today even if Medicare does not expand the penalty to include hospital-wide readmissions as currently proposed.³²

Beyond any possible impact from readmission penalties, functional impairments place a heavy burden on hospitalized seniors and their caregivers, thus providing additional, patient-centered motivation for hospitals to identify patients with functional impairments on admission. Unlike more complex problems such as unstable housing,³³ low socio-economic status,³⁴ or other factors contributing to “poor post-discharge environment,”³⁵ previous studies have consistently demonstrated the efficacy of well-defined interventions targeted to patients with functional impairments.^{36,37} Furthermore, measuring IADL and ADL impairments in hospital settings is easy. As a series of simple questions asked of patients or their caregivers, it requires no special equipment or training for staff and is often included in nursing intake assessments, although this information often does not copy to physician notes or billing documentation thus preventing the routine use of this information in hospital- or system-wide analyses of readmission or other outcomes of hospitalization.

Indeed, lack of adequate documentation, billing, or reporting of functional impairment is likely a key barrier to its prior and current use in readmission risk prediction models and transition interventions. For over a decade, Medicare has required collection and reporting of data on functional status in most post-acute care settings including skilled nursing facilities, acute rehabilitation facilities, long-term acute care hospitals, nursing homes, and home health agencies.³⁸ While Medicare is currently developing uniform standards for functional assessment across these post-care settings,³⁹ acute care hospitals are still not required or incentivized to collect and report any measures of functional status in hospitalized seniors. Given Medicare’s current policy focus on reducing readmissions, the consistency of a hospital’s assessment of function on admission might be an excellent target for future quality metrics.

Our study has several limitations. First, given the prospective nature of the HRS study, the time from our measurements of functional impairment and hospitalization were not uniform among HRS subjects (inter-quartile range 213–622 days, average 430 days). Although our sub-analyses of subjects with functional assessments within 6 months preceding admission was not significantly different than our main results, our analysis may under-estimate the effects of functional impairments at the actual time of hospital admission as functional status

typically declines in the setting of acute illness.^{40, 41} Second, we do not have Medicare claims data after 2012 when the current CMS readmission penalty was enacted; however, readmission rates have been publically reported by CMS since 2009 and national, unadjusted readmission rates have been stable at 18–19% from 2007–2012.⁴² Finally, although we created our cohort of hospitalized patients and our outcome of readmission to mirror the CMS readmission policy, we did not use the same adjustment procedures as CMS to calculate readmission rates. Since CMS intentionally does not adjust for factors such as gender, race, and SES, our analyses are comparatively “over-adjusted” and our estimated readmission rates are therefore conservative with respect to actual application of the CMS readmission policy.

In conclusion, we found that nearly half of hospitalized Medicare seniors have pre-admission functional impairments. Increasing severity of these functional impairments is associated with increased risk of 30-day, all-cause hospital readmission, especially those admitted for heart failure, myocardial infarction or pneumonia. Functional impairment on admission may be an overlooked but highly suitable target for interventions to reduce Medicare hospital readmissions.

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References

1. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med*. 2009; 360:1418–28. [PubMed: 19339721]
2. Centers for Medicare & Medicaid Services (CMS), HHS. Medicare program; hospital inpatient value-based purchasing program. Final rule. *Fed Regist*. 2011 May 6; 76(88):26490–547. [PubMed: 21548401]
3. National Quality Forum (NQF). Endorses All-Cause Unplanned Readmissions Measures. http://www.qualityforum.org/News_And_Resources/Press_Releases/2012/NQF_Endorses_All-Cause_Unplanned_Readmissions_Measures.aspx
4. National Committee for Quality Assurance. Proposed New Measure for HEDIS 2011: Plan All-Cause Readmissions. www.ncqa.org/Portals/0/.../Plan%20All-Cause%20Readmissions.pdf
5. Joynt KE, Jha AK. Thirty-day readmissions--truth and consequences. *N Engl J Med*. 2012; 366(15): 1366–1369. [PubMed: 22455752]
6. Kangovi S, Grande D. Hospital readmissions--not just a measure of quality. *JAMA*. 2011; 306(16): 1796–7. [PubMed: 22028356]
7. Kansagara D, Englander H, Salanitro A, et al. Risk prediction models for hospital readmission: a systematic review. *JAMA*. 2011; 306(15):1688–1698. [PubMed: 22009101]
8. Singh S, Lin YL, Kuo YF, Nattinger AB, Goodwin JS. Variation in the risk of readmission among hospitals: the relative contribution of patient, hospital and inpatient provider characteristics. *J Gen Intern Med*. 2014 Apr; 29(4):572–8. [PubMed: 24307260]
9. [Accessed April 24, 2014] Medicare and Medicaid Statistics Supplement, 2013 Edition – Chapter 2, Table 2.1: Medicare Enrollment. at: http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/MedicareMedicaidStatSupp/Downloads/2013_Section2.pdf#Table2.1

10. Ferrucci L, Guralnik JM, Pahor M, Corti MC, Havlik RJ. Hospital diagnoses, Medicare charges, and nursing home admissions in the year when older persons become severely disabled. *JAMA*. 1997; 277:728–734. [PubMed: 9042845]
11. Rozzini R, Sabatini T, Cassinadri A, Boffelli S, Ferri M, Barbisoni P, Frisoni GB, Trabucchi M. Relationship between functional loss before hospital admission and mortality in elderly persons with medical illness. *J Gerontol A Biol Sci Med Sci*. 2005 Sep; 60(9):1180–3. [PubMed: 16183960]
12. Covinsky KE, Palmer RM, Counsell SR, Pine ZM, Walter LC, Chren MM. Functional status before hospitalization in acutely ill older adults: validity and clinical importance of retrospective reports. *J Am Geriatr Soc*. 2000 Feb; 48(2):164–9. [PubMed: 10682945]
13. Xu H, Covinsky KE, Stallard E, Thomas J 3rd, Sands LP. Insufficient help for activity of daily living disabilities and risk of all-cause hospitalization. *J Am Geriatr Soc*. 2012 May; 60(5):927–33. [PubMed: 22587855]
14. Barnes DE, Mehta KM, Boscardin WJ, et al. Prediction of recovery, dependence or death in elders who become disabled during hospitalization. *J Gen Intern Med*. 2013 Feb; 28(2):261–8. [PubMed: 23054919]
15. Covinsky KE, Palmer RM, Fortinsky RH, Counsell SR, Stewart AL, Kresevic D, Burant CJ, Landefeld CS. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. *J Am Geriatr Soc*. 2003 Apr; 51(4):451–8. [PubMed: 12657063]
16. Depalma G, Xu H, Covinsky KE, Craig BA, Stallard E, Thomas J 3rd, Sands LP. Hospital readmission among older adults who return home with unmet need for ADL disability. *Gerontologist*. 2013 Jun; 53(3):454–61. [PubMed: 22859438]
17. Hoyer EH, Needham DM, Miller J, Deutschendorf A, Friedman M, Brotman DJ. Functional status impairment is associated with unplanned readmissions. *Arch Phys Med Rehabil*. 2013 Oct; 94(10):1951–8. [PubMed: 23810355]
18. Hoyer EH, Needham DM, Atanelov L, Knox B, Friedman M, Brotman DJ. Association of impaired functional status at hospital discharge and subsequent rehospitalization. *J Hosp Med*. 2014 Feb 26. Epub ahead of print. 10.1002/jhm.2152
19. Krumholz HM. Post-hospital syndrome--an acquired, transient condition of generalized risk. *N Engl J Med*. 2013 Jan 10; 368(2):100–2. [PubMed: 23301730]
20. Krumholz HM, Lin Z, Drye EE, Desai MM, Han LF, Rapp MT, Mattera JA, Normand SL. An administrative claims measure suitable for profiling hospital performance based on 30-day all-cause readmission rates among patients with acute myocardial infarction. *Circ Cardiovasc Qual Outcomes*. 2011 Mar; 4(2):243–52. [PubMed: 21406673]
21. Lindenauer PK, Normand SL, Drye EE, Lin Z, Goodrich K, Desai MM, Bratzler DW, O'Donnell WJ, Metersky ML, Krumholz HM. Development, validation, and results of a measure of 30-day readmission following hospitalization for pneumonia. *J HospMed*. 2011 Mar; 6(3):142–50.
22. Juster FT, Suzman R. An overview of the Health and Retirement Study. *J Hum Resour*. 1995; 30(suppl):S7–56.
23. The Health and Retirement Study. additional information available online at <http://hrsonline.isr.umich.edu/>
24. The Health and Retirement Study. [Cite accessed October 14, 2014] Sample Sizes and Response Rates. Available at: <http://hrsonline.isr.umich.edu/sitedocs/sampleresponse.pdf>
25. The Health and Retirement Study. [Cite accessed October 14, 2014] Survey Design and Sample Evolution. Available at: <http://hrsonline.isr.umich.edu/sitedocs/surveydesign.pdf>
26. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged: the index of ADL: a standardized measure of biological and psychosocial function. *JAMA*. 1963; 185:914–919. [PubMed: 14044222]
27. Fried LP, Guralnik JM. Disability in older adults: evidence regarding significance, etiology, and risk. *J Am Geriatr Soc*. 1997; 45(1):92–100. [PubMed: 8994496]
28. Covinsky KE, Hilton J, Lindquist K, Dudley RA. Development and validation of an index to predict activity of daily living dependence in community-dwelling elders. *Med Care*. Feb; 2006 44(2):149–157. [PubMed: 16434914]

29. Lawton MP, Moss M, Fulcomer M, Kleban MH. A research and service oriented multilevel assessment instrument. *J Gerontol.* 1982; 37(1):91–99. [PubMed: 7053405]
30. Hirsch CH, Sommers L, Olsen A, Mullen L, Winograd CH. The natural history of functional morbidity in hospitalized older patients. *J Am Geriatr Soc.* 1990 Dec; 38(12):1296–303. [PubMed: 2123911]
31. Rau, Jordan. [Site accessed May 29, 2014] Armed With Bigger Fines, Medicare To Punish 2,225 Hospitals For Excess Readmissions. *Kaiser Health News.* Aug 2. 2013 <http://www.kaiserhealthnews.org/stories/2013/august/02/readmission-penalties-medicare-hospitals-year-two.aspx>
32. MedPAC. [Cite accessed October 23, 2014] Report to Congress, Chapter 4: Refining the hospital readmissions reduction program. Jun. 2013 Available at: http://www.medpac.gov/documents/reports/jun13_ch04.pdf?sfvrsn=0
33. Doran KM, Ragins KT, Iacomacci AL, Cunningham A, Jubanyik KJ, Jenq GY. The revolving hospital door: hospital readmissions among patients who are homeless. *Med Care.* 2013 Sep; 51(9):767–73. [PubMed: 23929401]
34. Calvillo-King L, Arnold D, Eubank KJ, Lo M, Yunyongying P, Stieglitz H, Halm EA. Impact of social factors on risk of readmission or mortality in pneumonia and heart failure: systematic review. *J Gen Intern Med.* 2013 Feb; 28(2):269–82. [PubMed: 23054925]
35. Arbaje AI, Wolff JL, Yu Q, Powe NR, Anderson GF, Boulton C. Postdischarge environmental and socioeconomic factors and the likelihood of early hospital readmission among community-dwelling Medicare beneficiaries. *Gerontologist.* 2008 Aug; 48(4):495–504. [PubMed: 18728299]
36. Coleman EA, Parry C, Chalmers S, Min S. The Care Transitions Intervention: results of a randomized controlled trial. *Arch Intern Med.* 2006; 166:1828–28.
37. Naylor MD, Broton D, Campbell R, et al. Comprehensive discharge planning and home follow-up of hospitalized elders: a randomized clinical trial. *JAMA.* 1999; 281(7):613–20. [PubMed: 10029122]
38. Clauser SB, Bierman AS. Significance of functional status data for payment and quality. *Health Care Financ Rev.* 2003 Spring;24(3):1–12. [PubMed: 12894631]
39. [Site accessed May 23, 2014] Technical Expert Panel on the Development of Cross-Setting Functional Status Quality Measures. <http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/LTCH-Quality-Reporting/Downloads/Summary-of-Feedback-from-TEP-on-the-Development-of-Cross-Setting-Functional-Status-Quality.pdf>
40. Covinsky KE, Palmer RM, Fortinsky RH, et al. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. *J Am Geriatr Soc.* Apr; 2003 51(4):451–458. [PubMed: 12657063]
41. Fortinsky R, Covinsky KE, Palmer RM, et al. Effects of functional status changes before and during hospitalization on nursing home admission of older adults. *J Gerontol A Biol Sci Med Sci.* 1999; 54A:M521–M526. [PubMed: 10568535]
42. Gerhardt G, Yemane A, Hickman P, et al. Data Shows Reduction in Medicare Hospital Readmission Rates During 2012. *Medicare & Medicaid Research Review.* 2013; 3(2) Available at: http://www.cms.gov/mmrr/Downloads/MMRR2013_003_02_b01.pdf.

Table 1

HRS-Medicare 2000–2010 Cohort characteristics

	Total (N=22289)	No Readmission (N=18832)	Readmission (N=3457)	p-value
Demographics				
Age	78.5 ± 7.7	78.4 ± 7.7	79.0 ± 7.9	0.001
<75	8683	7353	1330	35%
75–85	8681	7396	1285	41%
85	4925	4083	842	24%
Male	9474	7919	1555	44%
Race/Ethnicity				
White	17365	14778	2587	85%
Black	3151	2583	568	10%
Latino	1541	1275	266	6%
Other/Unknown	232	196	36	1%
Married/Partnered	11456	9729	1727	47%
Income	24K (13K–42K)	24K (13K–43K)	21K (12K–38K)	<0.001
Wealth	132K (28K–375K)	137K (30K–387K)	103K (19K–305K)	<0.001
Education less than HS	7691	6405	1286	35%
Health Variables				
Self-Rated Health (Fair or Poor)	11085	9092	1993	56%
Number of Elixhauser comorbidities	6.0 ± 3.2	5.7 ± 3.2	7.2 ± 3.4	<0.001
Any Hospitalization in year prior to Index Hospitalization	19111	16354	2757	81%
Baseline Function				
Functional Level				
No Impairment of any kind	11352	9834	1518	45%
Difficulty with 1 IADL	3002	2523	479	13%
Difficulty with 1 ADL	3924	3297	627	18%
Dependency in 1–2 ADL	2525	2042	483	15%
Dependency in 3 ADL	1465	1123	342	9%

Table 2

Association of Functional Impairments with Hospital Readmission

	Readmission Odds Ratios (OR)			Readmission Predicted Probabilities (PP)		
	Unadjusted	Adjusted		Unadjusted	Adjusted	
Functional Impairment	OR	95% CI	AOR	95% CI	PP	95% CI
Overall						
No Impairments	1		1		15.2%	(13.9,14.9)
Difficulty with 1 IADL	1.19	(1.06,1.34)	1.06	(0.94,1.20)	13.3%	(12.6,14.0)
Difficulty with 1 ADL	1.23	(1.10,1.37)	1.08	(0.96,1.21)	15.5%	(14.1,16.9)
Dependency in 1-2 ADL	1.58	(1.40,1.79)	1.26	(1.11,1.44)	15.8%	(14.6,17.1)
Dependency in 3 ADL	1.96	(1.66,2.31)	1.42	(1.20,1.69)	19.6%	(17.8,21.3)
					23.1%	(20.3,25.9)
					14.4%	(12.9,15.6)
					14.4%	(13.2,15.6)
					16.5%	(14.9,18.1)
					18.2%	(15.9,20.5)

* Adjusted for age, gender, race, marital status, income, wealth, education, Elixhauser score, hospitalizations in the prior year

Table 3 Functional Impairment and Readmission for Targeted Medicare Diagnoses (heart failure, myocardial infarction, or pneumonia)

	Readmission Odds Ratios (OR)			Readmission Predicted Probabilities (PP)		
	Unadjusted		Adjusted	Unadjusted		Adjusted
	OR	95% CI	AOR	95% CI	PP	95% CI
Functional Impairment						
Overall						
No Impairments	1		1		16.5%	(14.4,19.5)
Difficulty with 1 IADL	1.08	(0.74,1.57)	0.97	(0.66,1.44)	17.6%	(11.9,21.1)
Difficulty with 1 ADL	1.32	(0.96,1.82)	1.14	(0.82,1.58)	20.8%	(14.9,22.8)
Dependency in 1-2 ADL	1.44	(1.03,2.02)	1.11	(0.77,1.61)	22.2%	(13.6,23.2)
Dependency in 3 ADL	2.60	(1.69,3.99)	1.70	(1.04,2.78)	34.0%	(17.2,34.2)

* Adjusted for age, gender, race, marital status, income, wealth, education, Elixhauser score, hospitalizations in the prior year