



Published in final edited form as:

Circ Cardiovasc Qual Outcomes. 2012 May 1; 5(3): 396–402. doi:10.1161/CIRCOUTCOMES.111.963116.

Predictors of Self-Report of Heart Failure in a Population-Based Survey of Older Adults

Tanya R. Gure, MD¹, Ryan J. McCammon, AB², Christine T. Cigolle, MD, MPH^{1,3,4}, Todd M. Koelling, MD⁵, Caroline S. Blaum, MD, MS^{1,3}, and Kenneth M. Langa, MD, PhD^{2,6,7}

¹ Division of Geriatric Medicine, Department of Internal Medicine, University Michigan, Ann Arbor, MI, USA.

² Division of General Internal Medicine, Department of Internal Medicine, University of Michigan, Ann Arbor, MI, USA.

³ Geriatric Research, Clinical and Education Center, VA Ann Arbor Healthcare System, Ann Arbor, MI, USA.

⁴ Department of Family Medicine, University of Michigan, Ann Arbor, MI, USA

⁵ Division of Cardiovascular Medicine, Department of Internal Medicine, University of Michigan, Ann Arbor, MI, USA

⁶ Veterans Affairs, VA Center for Practice Management & Outcomes Research, VA Ann Arbor Healthcare System, Ann Arbor, MI, USA.

⁷ Institute for Social Research, University of Michigan, Ann Arbor, MI, USA

Abstract

Background—Little research has been conducted on the predictors of the self-report or patient awareness of HF in a population-based survey. Objective: 1) test agreement between Medicare administrative and Health and Retirement Study (HRS) survey data and 2) determine predictors associated with self-report of HF, using a validated Medicare claims algorithm as the reference standard. We hypothesized that those who self-reported HF were more likely to have a higher number of HF-related claims.

Methods and Results—Secondary data analysis was conducted using the 2004 wave of the HRS linked to 2002-04 Medicare claims (n=5,573 respondents < 67 years old). Concordance between self-report of HF in the HRS and Medicare claims was calculated. Logistic regression was performed to identify predictors associated with self-report HF. HF prevalence by self-report was 4.6%. Self-report of HF and claims agreement was 87% (k=0.34). The presence of >1 HF inpatient claim was associated with greater odds of self-report (OR: 1.92; 95% CI: 1.23-3.00). Greater odds of self-reporting HF was also associated with < 4 HF claims (OR: 2.74; 95% CI: 1.36-5.52). Blacks and Hispanics were least likely to self-report HF compared to whites (blacks, OR: 0.28; 95% CI: 0.14-0.55; Hispanics: OR 0.30; 95% CI: 0.11-0.83) in the final model.

Correspondence to Tanya R. Gure, MD 300 North Ingalls Bldg., Rm. 925 Ann Arbor, MI 48109-2007 office: 734/763-4460 fax: 734/936-2116 tanruff@umich.edu.

Disclosures

Dr. Koelling received research funding from Medtronic, Inc., MESPERE, Inc. He received an honorarium from Abbott Vascular.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conclusions—Self-report of HF is an insensitive method for accurately identifying HF cases, especially in those with less severe disease and who are non-white. There may be limited awareness of HF among older minority patients despite having clinical encounters with during which HF is coded as a diagnosis.

Keywords

heart failure; Medicare claims; concordance

INTRODUCTION

Chronic heart failure (HF) is a common and complex chronic condition in older adults (1-5). HF is associated with increased disability and is frequently accompanied by other debilitating chronic conditions (6-8). Despite a number of initiatives designed to reduce the mortality and morbidity of older adults with HF, such as disease management programs and discharge planning services, outcomes have only slightly improved in older adults in the last decade (4, 9-13). The lack of substantial improvement in mortality and morbidity has prompted further consideration of the impact of comorbid conditions and psychosocial contextual factors (eg. caregiver support, patient functional status) on the health status of older adults with HF.

Population-based HF research can provide important information about the interrelationship of HF with psychosocial factors and other comorbid conditions, including geriatric syndromes. The Health and Retirement Study (HRS), a nationally-representative survey of adults older than 50, is an ideal data source for investigating the geriatric relevant chronic conditions and psychosocial contextual factors of older adults with HF. However, the self-reporting by respondents of their chronic diseases often underreports disease prevalence (14). In prior studies with the HRS, we found a 4% prevalence of self-reported HF in older adults 65 years, which is less than the estimates of 8-10% found with other population-based surveys that used expert clinical adjudication (3, 5, 6). A HF case definition developed from prior work used self-report of HF by telephone interview as the gold standard, to maximize the performance of claims-based algorithms (15). In it, six percent of 4,600 members of a Medicare Choice plan reported having HF in the year 2000. The patient population identified solely by self-report data in the HRS (and perhaps in the Medicare Choice telephone survey) may have more severe HF(16); thus, individuals who are less likely to self-report because of milder disease may be missed. Ascertainment of HF through self-report alone may lead to an over- or underestimation of outcomes of interest.

Patient awareness of HF as a condition is likely influenced by multiple factors besides illness severity, including socioeconomic background, race, patient health awareness gained through encounters with healthcare providers and effective self-management skills (17-22). However, little research has been conducted on the predictors of the self-report or patient awareness of HF in a population-based survey. Furthermore, those who under-report having HF, despite having administrative claims which indicate receiving healthcare for HF, likely represent important segments of the population who may have lower health literacy and higher vulnerability. Understanding the sociodemographic and health status variables associated with self-report of HF may also have important implications for targeting self-management education programs toward certain subpopulations of older adults with HF.

The objective of our study was to 1) test the agreement between Medicare claims and HRS survey data; and 2) determine the patient and health status characteristics associated with self-report of HF by utilizing comparison to the presence of a HF diagnosis code in linked Medicare claims as a reference standard. We hypothesized that those who self-reported HF

were more likely to have a higher number of inpatient clinical encounters related to care for HF.

METHODS

Data

We used data from the 2004 wave of the HRS a biennial, longitudinal survey of a nationally representative cohort of U.S. older adults(23). The HRS provides detailed self-report information on chronic diseases and task-specific disabilities.

Sample definition

Ninety percent of HRS respondents provided consent to link their Medicare claims to their HRS survey data. We were interested in viewing claims data two years prior to the 2004 interview to capture the greatest number of HRS respondents with HF in the Medicare claims data (15, 24). Of the 20,129 respondents in the 2004 survey wave, we restricted our analysis to the 9,663 respondents aged 67 and above, ensuring that each individual had 2 full years as a Medicare beneficiary during our surveillance period. The sample was reduced to 8,207 after exclusion of those HRS respondents who were not continuously enrolled in Medicare Parts A and B. We excluded 1,650 respondents who were enrolled in Medicare managed care because, by law, managed care plans are not required to report complete data. We excluded those subjects who were represented in the survey by proxy informants or were in a nursing home at the time of the analysis (n=804). Our analytic sample included 5,753 respondents with non-missing self-reported heart failure data, representative of a population of approximately 21.4 million adults, 67 years old with fee-for-service Medicare.

Definition of heart failure by self-report in the HRS

Self-report of HF was determined based on survey responses to questions in the HRS 2004 interview. Respondents were asked: “Has a doctor ever told you that you had a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems?” Those who responded “yes” were further asked “Has a doctor told you that you have congestive heart failure?” We categorized respondents as having HF if they answered “yes” to the latter question; those who responded “no” were categorized as not having HF.

Definition of heart failure by claims-based diagnosis

HF was defined with Medicare claims by making use of the International Classification of Diseases-Ninth Revision-Clinical Modification (ICD-9-CM) diagnosis codes for primary and secondary diagnoses. Using Medicare Part A and Part B claim files, we determined the claims-based diagnosis of HF for 2-year period prior to each respondent's HRS interview date (15). We employed ICD-9-CM coding algorithms to identify HF as a diagnosis in 1 claim from inpatient, outpatient and carrier files using codes 398.91, 402.01-402.91, 404.01-404.93, and 428.0-428.90 within a two-year period based on a previously published validated algorithm (15). Rector, et. al report a positive predictive value (PPV)=38% for finding HF cases among Medicare Choice plan members in whom the prevalence was 6 percent.

Independent variables

The sociodemographic variables included in the analysis as independent variables were: age, race, gender, net worth, and education.

Self-reported chronic conditions included: hypertension, lung disease, stroke, cancer, diabetes and psychiatric problem (captures emotional and mental health problems). We created a count variable of these conditions ranging from 0-6. The self-reported number of physician encounters was also utilized as a covariate. Respondents in the HRS were first asked, “(Aside from any hospital or nursing home stays), during the last 12 months, since (month) of (2004), have you seen a medical doctor about your health?” Respondents who said “yes” were then asked: “How many times have you talked to a medical doctor (about your own health) in the last 12 months?” Responses were coded into four categories (0-3, 4-7, 8-12, and 13 visits) for analysis.

For self-respondents, the HRS assesses cognitive function using a modified version of the Telephone Interview for Cognitive Status (TICS-m), a validated cognitive screening instrument patterned on the Mini-Mental State Examination (25). The TICS-m uses a 27-point scale that has high sensitivity and specificity for cognitive impairment and dementia in community samples of older adults (25-27). The test items include: 1) an immediate and delayed 10-word recall test to measure memory; 2) a serial seven subtraction test to measure working memory; and, 3) a counting backward test to measure speed of mental processing. Cut-points to identify subjects with cognitive impairment were based on the findings from the Aging, Demographics, and Memory Study (ADAMS) (28, 29). Cognitive function scores were created and categorized as normal (≥ 12 points) or cognitively impaired (CI) (< 12 points) with the CI category divided into mild (7-11) and moderate/severe impairment (0-6) based on prior work validating these cut-points.

Physical function variables included in the analysis were Activities of Daily Living (ADLs). A respondent was considered to have an ADL disability (bathing, dressing, eating, transferring, toileting and walking) if they reported having difficulty performing the ADL or required assistance. ADL limitations were dichotomized as 0, 1-2, and 3-6 to identify those with a low, medium, and high burden of ADL impairments, respectively.

Claims-based covariates

Heart failure claims-based covariates were chosen as indicator variables to measure poor health status. We counted the number of HF related claims present in all claim files of interest as a measure of healthcare utilization without defining discrete hospital or outpatient visits. This was operationalized 1, 2-3, 4-9, or ≥ 10 . Additionally, we created a dichotomous variable indicating the presence of an inpatient claim for HF if there were >1 inpatient claims with HF as the primary or secondary diagnosis.

STATISTICAL ANALYSIS

All analyses were conducted using SAS. Weighted analyses were conducted to calculate sample characteristics and conduct multivariate logistic regression analysis. Sample characteristics for the different groups were compared using chi-square and t-tests statistics, as appropriate, and were adjusted for the HRS complex sampling design.

The K statistic (K) was used to measure the agreement between the HRS survey data and Medicare claims. We investigated the sensitivity and specificity of the self-report of HF in the HRS using the Medicare claims data as the reference standard rather than self-report because of prior work indicating that older adults who have a particular condition tend to under-report its presence (30). We defined sensitivity as the proportion of HRS respondents with Medicare claims linked data that were identified by a claims-based algorithm as having heart failure (denominator) who self-reported that a doctor told them they had heart failure (numerator). We defined specificity as the proportion of HRS respondents not having a claims-based diagnosis of HF who did not self-report having the condition.

We used logistic regression to identify covariates associated with the likelihood of self-report of HF in the HRS. The final logistic models included the sociodemographic, health, and claims-based factors that influenced self-report of HF as a condition. Model 1 included age, gender, race and ethnicity, level of education, and net worth. Model 2 included Model 1 covariates in addition to respondents' cognitive status, number of chronic medical conditions, and number of healthcare provider encounters. Model 3 included Model 2 covariates in addition to the number of HF claims and the presence of HF inpatient claims.

RESULTS

Sample Characteristics

Among the 5,753 respondents in the analytic sample, the mean age was 76.4 years old, 39.9% were male, 7.0% were Black, and 3.2% were Hispanic (Table 1). The mean number of years of education was 12.2. Ten percent of the entire sample had 4 chronic conditions; 35.6% had 1 chronic conditions.

Characteristics of true positive and false negative populations

True positives (self-report of HF and 1 HF claim present) comprised 3.9% (n=216) of the total sample; false negatives (no self-report of HF, and 1 HF claim) comprised 11.6% (Table 1). The proportion of whites was higher in the true positive subgroup than the false negative subgroup (92.5% vs. 84.8%; $p < .001$). Conversely, higher proportions of blacks and Hispanics were found in the false negative subgroup, although, the number of Hispanics was small (TP: blacks, row %: 2.9%; Hispanics, row %: 2.8) (FN: blacks, row % 17.4%; Hispanics, row %: 17.0%). Although there are significant differences when comparing all four subgroups, there were no differences in the mean number of years of education, number of ADL limitations, or mean net worth, between the true positive and false negative subgroups. There was no difference in the cognitive scores between the true positive and false negative subgroups (TP: 65.8% normal, 34.2% impaired; FN: 60.9% normal; 39.0% impaired; p values $> .10$ in all between-group comparisons). The true positive subgroup had a greater mean number of chronic conditions compared to the false negative subgroup (2.9 vs. 2.4; $p < .001$). Also, the true positive subgroup had more encounters with a health provider (23 vs. 16.3; $p < .001$). The true positive subgroup was more likely than the false negative subgroup to possess 1 inpatient claims with a diagnosis of HF (TP 63.6% vs. 30.7%; $p < .001$) (Table 2). Similarly, the true positive subgroup had more HF claims than the false negative subgroup (mean of 12.9 vs. 5.4; $p < .001$).

Sensitivity and specificity of self-report of heart failure

Of the 5,753 respondents, 15.5% had a Medicare claim with a HF diagnosis during the two-year period preceding the 2004 HRS interview (Table 3). Self-reported prevalence of HF in the 2004 interview was 4.6%. Interestingly, few respondents (15% of those self-reporting HF) over-reported heart failure (false positives). Under-reporting was much more common: while 896 subjects had 1 HF diagnostic claim, 75% subjects did not self-report the condition. Sensitivity of self-report of HF was 25.2%, with a specificity of 99.2%. The agreement between self-report of HF and claims for HF diagnosis was 87.7%; $\kappa = 0.34$. We found no notable differences in test-operating characteristics with use of other ICD-9 coding algorithms as the reference standard such as use of 428 diagnosis codes as primary diagnosis, 428 codes as 1° and 2° diagnosis, or using 2 Medicare claims.

Sociodemographic, health status, and claims-based predictors associated with self-report of heart failure

The adjusted odds ratios from the logistic regression models for the 896 respondents classified as either true-positives or false-negatives are shown in Table 4. These models predict the likelihood of self-report of HF, or in other words, the predictors of being a true positive (self-report of HF and 1 Medicare claims with HF within a 2-year period as the diagnosis). Respondents with more comorbidity were more likely to self-report HF as a chronic condition. The presence of >1 HF inpatient claim was associated with greater odds of self-report (OR: 1.92; 95% CI: 1.23-3.00). Those with 4 HF claims of any kind also had greater odds of self-reporting the condition (OR: 2.74; 95% CI: 1.36-5.52). The joint contribution of the # of HF claims and presence of an inpatient claim, as an indication of poor health status, significantly contributed to the model 3 (Wald Chi-square test = 81.69, df=4).

In all models, blacks were least likely to self-report HF compared to whites (in final model 3, OR: 0.28; 95% CI: 0.14-0.55) even after controlling for number of health provider encounters and poorer health status as measured by the presence of an inpatient HF claim and a greater number of HF claims. Similarly, a lower likelihood of self-reporting HF was also noted for the Hispanics compared to whites (final model 3, OR .30; 95% CI: 0.11-0.83). The effect of the number of physician visits was decreased by including administrative claims and comorbidity burden as covariates in the final model. Net worth was a modest predictor of true positive status in model 1, but had no significant effect in the final model. Gender, years of education, and cognitive function were not significant predictors of a true positive HF diagnosis.

DISCUSSION

Using nationally-representative data from the HRS linked to Medicare claims, this study characterizes the predictors of self-report of HF, using as a reference standard, a validated algorithm for HF diagnosis based on Medicare claims. In addition, we report the test operating characteristics of self-report of HF using the claims-based algorithm as the reference standard. The specificity of self-report of HF is 99%, with a false positive rate of 1%. If a subject reports having HF, then it's highly probable that the condition exists. However, the high false negative rate (sensitivity=25%) makes it difficult to exclusively rely on self-report of the condition as an appropriate method for HF case-finding. This study enhances understanding of the strengths and limitations in use of self-report of HF alone. Also, this work further emphasizes the importance of future work to improve our accuracy in identifying HF cases within population-based surveys.

The agreement between self-report and claims for HF diagnosis found in this study (total agreement: 87.7%; kappa= 0.34) is consistent with prior work examining the concordance between self-report and the medical record. There is excellent concordance between claims data and self-report for other chronic conditions such as diabetes and acute myocardial infarction. However, only fair concordance has been reported in ambulatory managed care medical records and patient self-report of HF, with 86% total agreement and kappa of 0.3 (31).

The primary strength of this study is its use of linked HRS-Medicare claims data to investigate the predictors associated with under-reporting of HF. This analysis aimed to identify factors associated with true positives and false negatives, by performing multivariate logistic regression to predict the likelihood of self-report of HF. Older adults were more likely to report HF if they had poorer health status, suggested by the presence of inpatient claims suggesting acute care provisions for HF and a greater number of total

claims for which HF was a primary or secondary diagnosis. We also found that Blacks and Hispanics were least likely to report having HF as compared to whites. Even after controlling for the number of health care encounters with a provider, respondents from minority groups still had lower odds of self-reporting HF. Underreporting of HF in blacks is especially troubling given the disproportionate burden of HF in older blacks compared to whites (32-37). HF is a condition that may be under-recognized in minority populations, despite having clinical encounters with healthcare providers during which HF is coded as a diagnosis.

Several limitations of our study warrant mention. Medicare claims data are a less-than-ideal reference standard measurement of HF. The validity of Medicare administrative data depends on many factors: ICD-9 coding practices, organizational culture, coder experience, and the type of administrative file utilized(16). A particularly important bias is the financial incentive health systems have to code HF as a diagnosis. These claims could be “upcoded” for patients without a diagnosis of HF or utilized for those with HF whose primary reason for the hospitalization or outpatient visit is another diagnosis. The most likely effect is to cause an overestimation of our HF case counts and compromise our accuracy in estimating concordance. Despite these limitations, the data we report on describing the concordance between self-report of HF in older adults and Medicare claims-based diagnosis of HF is useful and provides us an opportunity to further our HF case-finding methodological work. Ultimately, this will allow us to explore geriatric- specific and psychosocial outcomes in older adults with HF in ways that were previously limited with HRS survey data alone.

We analyzed data for respondents with HRS-Medicare claims data 67 years old to utilize 2 years of Medicare claims as described in a prior validated algorithm(15); however, there may be bias associated with omitting those who are Medicare eligible at 65 years. Medical records were not available for survey respondents with claims data to further adjudicate HF cases. Approximately 11% of the HRS respondents did not consent to the linkage of their survey data to Medicare claims. Our sample does not include persons with Medicare HMO plans because their claims data were not accessible. These factors may introduce selection bias since the population enrolled in managed care programs greatly differs from those with traditional Medicare fee-for-service plans with respect to health and socioeconomic status(38). Our estimates are conservative because survey respondents represented by a proxy are excluded; those respondents with the most severe cognitive impairment are excluded from the analysis.

The prevalence of HF based on self-report alone is approximately 5%, an undercount of the true prevalence based on prior published work (3, 5). Self-report of HF is predicted by white race and severity of HF as measured by number of HF claims, the use of inpatient care, and degree of comorbidity burden. Respondent report of HF is an insensitive method for accurately identifying HF cases, especially in those with less severe disease and who are non-white. Our results suggest that about 2.5 million individuals 67 years with HF are missed if only true positive self-reported cases are counted, including 266,000 blacks and 120,000 Hispanic individuals. This study suggests that caution should be exercised when self-report of HF is exclusively relied upon for health services research. Furthermore, current claims-based algorithms to ascertain a HF cases based on a previously validated method by Rector, et. al. may not reliably capture a broader disease mix of HF cases or an ethnically diverse population (15). More research is needed to develop effective claims-based algorithms which allow for the study of heterogeneous (clinically and ethnically) HF populations within unique data sources such as the HRS linked to Medicare claims data. Finally, this study suggests that there may be limited awareness of HF within older black and Hispanic populations despite having clinical encounters with healthcare providers during which HF is coded as a diagnosis.

Acknowledgments

Prior Presentations: An earlier version of this work was presented at the American Geriatrics Society National Meeting May 14, 2010.

Sources of Funding

The National Institute on Aging (NIA) provides funding for the Health and Retirement Study (U01 AG09740), which is performed at the Institute for Social Research, University of Michigan. Dr. Langa was supported by NIA grants R01 AG027010 and R01 AG030155. Drs. Blaum and Cigolle were supported by the Ann Arbor VA Geriatric Research, Clinical and Education Center. Dr. Cigolle was supported by a Mentored Clinical Scientist Research Career Development Award (K08 AG031837). Dr. Koelling was supported by Medtronic, Inc. and MESPERE, Inc. Dr. Gure was supported by an NIA Diversity Supplement award (R01 AG027010-02S1). Drs. Cigolle and Gure were supported by the John A. Hartford Foundation Center of Excellence, the NIA Claude D. Pepper Center Research Career Development Core, and the National Center for Research Resources (UL1 RR024986). The content is solely the responsibility of the authors and does not necessarily represent the official views of NCRR or the National Institutes of Health.

References

- Gill TM, Allore HG, Holford TR, Guo Z. Hospitalization, restricted activity, and the development of disability among older persons. *Jama*. 2004; 292:2115–24. [PubMed: 15523072]
- Wolinsky FD, Overhage JM, Stump TE, Lubitz RM, Smith DM. The risk of hospitalization for congestive heart failure among older adults. *Med Care*. 1997; 35:1031–43. [PubMed: 9338529]
- Kitzman DW, Gardin JM, Gottdiener JS, Arnold A, Boineau R, Aurigemma G, Marino EK, Lyles M, Cushman M, Enright PL. Cardiovascular Health Study Research G. Importance of heart failure with preserved systolic function in patients \geq 65 years of age. CHS Research Group. Cardiovascular Health Study. *Am J Cardiol*. 2001; 87:413–9. [PubMed: 11179524]
- Jessup M, Abraham WT, Casey DE, Feldman AM, Francis GS, Ganiats TG, Konstam MA, Mancini DM, Rahko PS, Silver MA, Stevenson LW, Yancy CW, Hunt SA, Chin MH, Heart Failure Writing C, Writing Comm M. 2009 Focused Update: ACCF/AHA Guidelines for the Diagnosis and Management of Heart Failure in Adults A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2009; 119:1977–2016. [PubMed: 19324967]
- Gillum RF. Epidemiology of heart failure in the United States. *Am Heart J*. 1993; 126:1042–7. [PubMed: 8213434]
- Gure TR, Kabeto MU, Blaum CS, Langa KM. Degree of disability and patterns of caregiving among older Americans with congestive heart failure. *J Gen Intern Med*. 2008; 23:70–6. [PubMed: 18030537]
- Braunstein JB, Anderson GF, Gerstenblith G, Weller W, Niefeld M, Herbert R, Wu AW. Noncardiac comorbidity increases preventable hospitalizations and mortality among Medicare beneficiaries with chronic heart failure. *J Am Coll Cardiol*. 2003; 42:1226–33. [PubMed: 14522486]
- Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. *Archives of Internal Medicine*. 2002; 162:2269–76. [PubMed: 12418941]
- Fonarow GC, Abraham WT, Albert NM, Stough WG, Gheorghide M, Greenberg BH, O'Connor CM, Pieper K, Sun JL, Yancy CW, Young JB, Hosp OHI. Influence of a performance-improvement initiative on quality of care for patients hospitalized with heart failure - Results of the organized program to initiate lifesaving treatment in hospitalized patients with heart failure (OPTIMIZE-HF). *Archives of Internal Medicine*. 2007; 167:1493–502. [PubMed: 17646603]
- Curtis LH, Greiner MA, Hammill BG, Kramer JM, Whellan DJ, Schulman KA, Hernandez AF. Early and Long-term Outcomes of Heart Failure in Elderly Persons, 2001–2005. *Archives of Internal Medicine*. 2008; 168:2481–8. [PubMed: 19064833]
- Jencks SF, Williams MV, Coleman EA. Rehospitalizations among Patients in the Medicare Fee-for-Service Program. *New England Journal of Medicine*. 2009; 360:1418–28. [PubMed: 19339721]

12. Kosiborod M, Lichtman JH, Heidenreich PA, Normand S-LT, Wang Y, Brass LM, Krumholz HM. National Trends in Outcomes Among Elderly Patients with Heart Failure. *The American Journal of Medicine*. 2006; 119:616, e1–e7. [PubMed: 16828634]
13. Bueno H, Ross JS, Wang Y, Chen J, Vidán MT, Normand SL, Curtis JP, Drye EE, Lichtman JH, Keenan PS, Kosiborod M, Krumholz HM. Trends in length of stay and short-term outcomes among Medicare patients hospitalized for heart failure, 1993-2006. *Jama*. 2010; 303:2141–7. [PubMed: 20516414]
14. Bowlin SJ, Morrill BD, Nafziger AN, Lewis C, Pearson TA. Reliability and changes in validity of self-reported cardiovascular disease risk factors using dual response: the behavioral risk factor survey. *J Clin Epidemiol*. 1996; 49:511–7. [PubMed: 8636724]
15. Rector TS, Wickstrom SL, Shah M, Thomas Greenlee N, Rheault P, Rogowski J, Freedman V, Adams J, Escarce JJ. Specificity and sensitivity of claims-based algorithms for identifying members of Medicare plus Choice health plans that have chronic medical conditions. *Health Serv Res*. 2004; 39:1839–57. [PubMed: 15533190]
16. Quach S, Blais C, Quan H. Administrative data have high variation in validity for recording heart failure. *Canadian journal of cardiology*. 2010; 26:306–12. [PubMed: 20931099]
17. Bersamin A, Stafford RS, Winkleby MA, Bersamin A, Stafford RS, Winkleby MA. Predictors of hypertension awareness, treatment, and control among Mexican American women and men. *J Gen Intern Med*. 2009; 24(Suppl 3):521–7. [PubMed: 19842001]
18. Huttin C, Moeller JF, Stafford RS. Patterns and costs for hypertension treatment in the United States - Clinical, lifestyle and socioeconomic predictors from the 1987 National Medical Expenditures Survey. *Clinical Drug Investigation*. 2000; 20:181–95.
19. Ostchega Y, Dillon CF, Hughes JP, Carroll M, Yoon S. Trends in hypertension prevalence, awareness, treatment, and control in older US Adults: Data from the National Health and Nutrition Examination Survey 1988 to 2004. *J Am Geriatr Soc*. 2007; 55:1056–65. [PubMed: 17608879]
20. Ostchega Y, Hughes JP, Wright JD, McDowell MA, Louis T. Are demographic characteristics, health care access and utilization, and comorbid conditions associated with hypertension among US adults? *American Journal of Hypertension*. 2008; 21:159–65. [PubMed: 18188162]
21. Sudman, S.; Bradburn, NM. *Response Effects in Surveys*. Aldine Publishing Company; Chicago: 1974.
22. Andersen, RM.; Kasper, J.; Frankel, MR. *Total survey error: applications to improve health surveys*. Jossey-Bass Publishers; San Francisco: 1979.
23. Myers GC, Juster FT, Suzman RM. Asset and Health Dynamics Among the Oldest Old (AHEAD): initial results from the longitudinal study. Introduction. *J Gerontol B Psychol Sci Soc Sci*. 1997; 52:v–viii. Spec No. [PubMed: 9215353]
24. Birman-Deych E, Waterman AD, Yan Y, Nilasena DS, Radford MJ, Gage BF. Accuracy of ICD-9-CM codes for identifying cardiovascular and stroke risk factors. *Med Care*. 2005; 43:480–5. [PubMed: 15838413]
25. Plassman BL, Newman TT, Welsh KA, Helms M, Breitner JCS. Properties of the Telephone Interview for Cognitive Status - Application in Epidemiologic and Longitudinal Studies. *Neuropsychiatr Neuropsychol Behav Neurol*. 1994; 7:235–41.
26. Welsh KA, Breitner JCS, Magruderhabib KM. Detection of Dementia in the Elderly Using Telephone Screening of Cognitive Status. *Neuropsychiatr Neuropsychol Behav Neurol*. 1993; 6:103–10.
27. de Jager CA, Budge MM, Clarke R. Utility of TICS-M for the assessment of cognitive function in older adults. *Int J Geriatr Psychiatry*. 2003; 18:318–24. [PubMed: 12673608]
28. Langa, KM.; Kabeto, MU.; Weir, D. Percentage of Americans Aged 55 and Older with Selected Diseases by Race/Ethnicity and Cognitive Status, Health and Retirement Study, 2006. 2010 Alzheimer's Disease Facts and Figures. Provided under contract to the Alzheimer's Association; 2010.
29. Langa KM, Plassman BL, Wallace RB, Herzog AR, Heeringa SG, Ofstedal MB, Burke JR, Fisher GG, Fultz NH, Hurd MD, Potter GG, Rodgers WL, Steffens DC, Weir DR, Willis RJ. The aging, demographics, and memory study: Study design and methods. *Neuroepidemiology*. 2005; 25:181–91. [PubMed: 16103729]

30. Turner CF, Smith TK, Fitterman LK, Reilly T, Pate K, Witt MB, McBean AM, Lessler JT, Forsyth BH. The quality of health data obtained in a new survey of elderly Americans: a validation study of the proposed Medicare Beneficiary Health Status Registry (MBHSR). *J Gerontol B Psychol Sci Soc Sci.* 1997; 52:S49–58. [PubMed: 9008681]
31. Tisnado DM, Adams JL, Liu H, Damberg CL, Chen W-P, Hu FA, Carlisle DM, Mangione CM, Kahn KL. What is the Concordance Between the Medical Record and Patient Self-Report as Data Sources for Ambulatory Care? *Med Care.* 2006; 44:132–40. [PubMed: 16434912]
32. Alexander M, Grumbach K, Remy L, Rowell R, Massie BM. Congestive heart failure hospitalizations and survival in California: patterns according to race/ethnicity. *Am Heart J.* 1999; 137:919–27. [PubMed: 10220642]
33. Alexander M, Grumbach K, Selby J, Brown AF, Washington E. Hospitalization for congestive heart failure. Explaining racial differences. *JAMA (Chicago, Ill).* 1995; 274:1037–42.
34. Dries DL, Exner DV, Gersh BJ, Cooper HA, Carson PE, Domanski MJ. Racial differences in the outcome of left ventricular dysfunction. *The New England journal of medicine.* 1999; 340:609–16. [PubMed: 10029645]
35. Loehr LR, Rosamond WD, Chang PP, Folsom AR, Chambless LE. Heart failure incidence and survival (from the Atherosclerosis Risk in Communities study). *Am J Cardiol.* 2008; 101:1016–22. [PubMed: 18359324]
36. Bahrami H, Kronmal R, Bluemke DA, Olson J, Shea S, Liu K, Burke GL, Lima JA. Differences in the incidence of congestive heart failure by ethnicity: the multi-ethnic study of atherosclerosis. *Archives of Internal Medicine.* 2008; 168:2138–45. [PubMed: 18955644]
37. Kalogeropoulos A, Georgiopoulou V, Kritchevsky SB, Psaty BM, Smith NL, Newman AB, Rodondi N, Satterfield S, Bauer DC, Bibbins-Domingo K, Smith AL, Wilson PW, Vasan RS, Harris TB, Butler J. Epidemiology of incident heart failure in a contemporary elderly cohort: the health, aging, and body composition study. *Archives of Internal Medicine.* 2009; 169:708–15. [PubMed: 19365001]
38. Shimada SL, Zaslavsky AM, Zaborski LB, O'Malley AJ, Heller A, Cleary PD. Market and beneficiary characteristics associated with enrollment in Medicare managed care plans and fee-for-service. *Med Care.* 2009; 47:517–23. [PubMed: 19365291]

Table 1

Demographic and health statistics of sample population of older adults 67 years with Health and Retirement Study data linked to Medicare claims (n=5,753)

Characteristics	True Positive n=216	False Positive n=39	False Negative n=680	True Negative n=4,818	Total	P-value
n	830,649	151,475	2,465,043	17,979,558	21,426,725	
weighted n	830,649	151,475	2,465,043	17,979,558	21,426,725	
Prevalence						
% (95% CI)	3.9 (3.3-4.5)	0.7 (0.4-1.00)	11.6 (10.7-12.5)	83.8 (82.7-84.8)		
Age mean (sd)	78.2 (6.6)	76.7 (5.9)	78.7 (6.8)	76.0 (6.4)	76.4 (6.5)	< .001
Race/ethnicity						< .001
Hispanic	8 (2.3)	2 (1.9)	49 (4.7)	225 (3.1)	284 (3.2)	
Black	20 (5.2)	6 (10.5)	101 (10.5)	517 (6.5)	644 (7.0)	
White/Other	188 (92.5)	31 (87.6)	530 (84.8)	4,076 (90.4)	4,825 (89.8)	
Gender						.057
Male	90 (41.3)	17 (45.7)	308 (44.6)	1,920 (39.2)	2,335 (39.9)	
Female	126 (58.7)	22 (54.3)	372 (55.4)	2,898 (60.8)	3,418 (60.1)	
Years of education						
Mean (sd)	11.6 (3.0)	11.6 (3.5)	11.5 (3.5)	12.4 (3.1)	12.2 (3.1)	< .001
Net worth (quartile)						< .001
\$61,000	83 (36.7)	15 (29.3)	247 (34.8)	1,128 (21.5)	1,473 (23.7)	
61,001-203,400	55 (26.2)	14 (33.3)	191 (27.6)	1,212 (24.9)	1,472 (25.3)	
203,401-512,000	44 (19.8)	7 (26.1)	137 (20.2)	1,238 (26.5)	1,426 (25.5)	
512,000	34 (17.3)	3 (11.3)	105 (17.3)	1,240 (27.1)	1,382 (25.5)	
Characteristics	True Positive n=216	False Positive n=39	False Negative n=680	True Negative n=4,818	Total	P-value
n (%)	830,649	151,475	2,465,043	21,426,725		
weighted n	830,649	151,475	2,465,043	21,426,725		
# ADL impairments						< .001
0	112 (55.2)	23 (58.4)	460 (68.4)	4,048 (83.9)	4,643 (80.8)	
1-2	72 (31.6)	12 (29.5)	155 (22.8)	591 (12.7)	830 (14.7)	
3-6	32 (13.2)	4 (12.1)	64 (8.8)	179 (3.4)	279 (4.5)	
Mean (sd)	1.0 (1.5)	0.8 (1.2)	0.7 (1.3)	0.3 (0.8)	0.4 (0.9)	< .001

Characteristics	True Positive	False Positive	False Negative	True Negative	Total	P-value
n (%)	n=216	n=39	n=680	n=4,818		
weighted n	830,649	151,475	2,465,043	21,426,725		
Cognitive function						
Normal	139 (65.8)	22 (54.3)	407 (60.9)	3,559 (75.2)	4,127 (73.0)	< .001
Mild	18(22.5)	16 (40.3)	201 (29.4)	988 (19.6)	1,252 (21.0)	
Moderate/Severe	30 (11.7)	1 (5.4)	72 (9.6)	271 (5.2)	374 (5.9)	
Provider visits						
Mean (sd)	23.0 (22.8)	14.7 (13.7)	16.3 (17.7)	9.9 (11.9)	11.2 (13.7)	< .001
# Chronic conditions						
Mean (sd)	2.9 (1.4)	2.8 (1.1)	2.4 (1.2)	1.9 (1.1)	2.0 (1.2)	< .001

Claims-based characteristics of sample population of older adults 67 years with Health and Retirement Study data linked to Medicare claims (n=5,753)

Table 2

Characteristics	True Positive	False Positive	False Negative	True Negative	Total	P-value
n (%)	n=216	n=39	n=680	n=4,818		
weighted n	830,649	151,475	2,465,043	21,426,725		
Inpatient HF claim						
No	78 (36.4)	n/a	472 (69.3)	n/a	550 (61.0)	< .001
Yes	138 (63.6)	n/a	208 (30.7)	n/a	346 (39.0)	
# HF claims						
1	19 (7.7)	n/a	212 (31.2)	n/a	231 (25.3)	< .001
2-3	34 (16.1)	n/a	180 (26.5)	n/a	214 (23.9)	
4-9	52 (24.2)	n/a	172 (25.8)	n/a	224 (25.4)	
10	111 (52.0)	n/a	116 (16.5)	n/a	227 (25.5)	
Mean (sd)	12.9 (12.4)		5.4 (7.0)		7.3 (9.3)	< .001

Table 3

Concordance of self-report of HF and presence of 1 HF diagnosis claim

	Medicare HF diagnosis	No Medicare HF diagnosis	Total
Self-report HF	N=216 Row=84.6% Column=25%	N=39 Row=15% Column=0.8%	N=255 (4.6%)
No self-report HF	N=680 Row=12.2% Column=75%	N=4,818 Row=87.8% Column=99.2%	N=5,498 (95.4%)
Total	N=896 (15.5%)	N=4,857 (83.7%)	N=5,753
<u>Weighted percentage</u>			
Sensitivity:	25.2%		
Specificity:	99.2%		
Positive predictive value:	84.6%		
Negative predictive value:	87.8%		
Kappa statistic:	0.34; 87.7% agreement		

Table 4

Logistic regression models of self-report of HF among those with Medicare HF claims (n=896)

Self-Report of Heart Failure			
OR (95% CI)	Model 1	Model 2	Model 3
Age	0.99 (0.96, 1.01)	0.99 (0.96, 1.01)	0.98 (0.95, 1.00)
Race or ethnicity			
White/Other (ref)	1.00	1.00	1.00
Hispanic	0.41 (0.15, 1.13)	0.34* (0.12, 1.01)	0.30* (0.11, 0.83)
Black	0.37** (0.20, 0.68)	0.35*** (0.19, 0.64)	0.28*** (0.14, 0.55)
Gender			
Male (ref)	1.00	1.00	1.00
Female	1.11 (0.77, 1.60)	0.97 (0.67, 1.39)	0.96 (0.63, 1.46)
Years of Education			
0-11	0.97 (0.61, 1.55)	0.96 (0.57, 1.63)	0.90 (0.47, 1.70)
12 (ref)	1.00	1.00	1.00
13-15	1.44 (0.88, 2.35)	1.49 (0.89, 2.47)	1.72 (0.93, 3.16)
16	0.97 (0.59, 1.59)	0.94 (0.59, 1.50)	0.92 (0.51, 1.66)
Log (Net worth)	0.96** (0.93, 0.99)	0.96 (0.93, 1.00)	0.96 (0.93, 1.00)
Number of ADL limitations			
None (ref)		1.00	1.00
1-2		1.55 (0.96, 2.52)	1.51 (0.91, 2.49)
3-6		1.52 (0.84, 2.74)	1.30 (0.70, 2.41)
Cognitive function			
Normal (ref)		1.00	1.00
Mild impairment		0.71 (0.47, 1.07)	0.69 (0.45, 1.06)
Moderate/severe		1.23 (0.79, 1.93)	1.20 (0.71, 2.02)
Number of Chronic conditions			
0-1 (ref)		1.00	1.00
2		1.13 (0.71, 1.79)	1.15 (0.68, 1.93)
3		1.47 (0.87, 2.48)	1.57 (0.92, 2.70)
4		1.96** (1.25, 3.10)	1.73 (0.93, 3.22)
Provider encounters			
0-3 (ref)		1.00	1.00
4-7		0.86 (0.39, 1.90)	0.74 (0.34, 1.61)
8-12		1.72 (0.93, 3.16)	1.28 (0.63, 2.61)
13		2.26* (1.11, 4.60)	1.49 (0.71, 3.13)
Inpatient HF claim			
No (ref)			1.00
Yes			1.92** (1.23, 3.00)
Number of HF claims			

Self-Report of Heart Failure

OR (95% CI)	Model 1	Model 2	Model 3
1 (ref)			1.00
2-3			2.08 (0.97, 4.47)
4-9			2.74 ** (1.36, 5.52)
10			8.15 *** (3.72, 17.83)

Log=log-transformed

Odds ratios and confidence intervals are weighted and corrected for the complex sampling design.

*
p .05

**
p .01

p .001