Mortality After Hospitalization for Heart Failure in Blacks Compared with Whites

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Running Title: Race and Mortality after HF Hospitalization

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ABSTRACT

Heart Failure (HF) disproportionately affects black compared with white Americans and overall mortality from HF is higher among blacks. Paradoxically, mortality rates after a hospitalization for HF are lower in black compared with white patients. These racial differences may reflect hospital, physician, and patient factors and may have implications for comparative hospital profiles. We identified published studies reporting post-hospitalization mortality for black and white patients with a discharge diagnosis of HF and conducted random-effects meta-analyses with the outcome of all-cause mortality. We included 29 cohorts of hospitalized black and white patients with HF. Unadjusted mean mortality rates after HF hospitalization for black and white patients, respectively, were 6% and 9% (in-hospital), 6% and 10% (30-day mortality), 10% and 15% (60-180 day mortality), 28% and 34% (1 year mortality) and 41% and 47% (mortality after 1 year). Unadjusted combined odds ratios (OR) for mortality in black compared with white patients ranged from 0.48 in-hospital (95% CI 0.45-0.51) to 0.77 after more than 1 year follow-up (95% CI 0.75-0.79). In meta-analyses using adjusted data, the combined OR was 0.68 for short-term mortality (95% CI 0.63 – 0.74), and the combined hazard ratio was 0.84 for long-term mortality (95% CI 0.77-0.91). In conclusion, mortality after hospitalization for HF was 32% lower in short-term follow-up and 16% lower in long-term follow-up for black compared with white patients. The mortality differences imply unmeasured differences by race in clinical severity of illness at hospital admission and may lead to biased hospital mortality profiles.

Key Words: heart failure, blacks, mortality, quality of hospital care

INTRODUCTION

After a hospitalization for heart failure (HF), numerous reports indicate that mortality is lower in black compared with white patients;[1-25] and a few studies report that mortality is similar.[26, 27] This lower or similar reported mortality in hospitalized black patients with HF is not accompanied by reports of substantially better quality of care in black compared with white patients..[27, 28] Moreover, national and ambulatory cohorts of patients with HF demonstrate higher or similar mortality in black compared with white patients.[29, 30] The comparison of HF mortality by race among either population-based or ambulatory-based cohorts on one hand, with hospital-based cohorts on the other hand, highlights a paradox in HF mortality by race. This observation that lower reported mortality among black patients occurs only in hospital-based cohorts suggests systematic differences in the clinical composition of hospital-based cohorts by race. Although studies have documented both lower and similar mortality in black patients compared with white patients after a HF hospitalization, these findings have not to our knowledge been reviewed and examined together. The objective of this study was to examine studies reporting mortality by race after a hospitalization for HF and combine the results using meta-analyses.

METHODS

We searched MEDLINE, CINAHL, Web of Science, PsycINFO, and SPORTDiscus from 1985 to March 2009. Our keywords were *mortality, heart failure,* and the combination of *black or African American*. We limited the results to articles in English, and we excluded letters, abstracts, conference proceedings, reviews, and editorials. In addition, we examined the citation sections of eligible studies for other relevant articles.

We included studies that reported mortality by race in a cohort of black and white adult patients hospitalized with HF. Studies were limited to those examining patients hospitalized in

the US or Canada because definitions of race may differ elsewhere. Studies were excluded if the authors did not report an odds ratio (OR), hazard ratio (HR), or provide enough information to calculate an OR for mortality in black compared with white patients. Studies examining outcomes in peripartum cardiomyopathy were excluded. Two board-certified physician reviewers (H.G., internal medicine, and A.D., cardiology) and 2 statistical reviewers (P.N. and D.M.) independently screened the titles and abstracts of studies to identify those fulfilling the inclusion criteria. The full article was reviewed by at least 3 reviewers to verify inclusion (when all reviewers agreed) and to resolve disagreements (when at least 1 reviewer voted to include an article). Articles selected for inclusion were evaluated again by the statistical reviewers to determine suitability for meta-analysis.

An abstraction form was used to collect descriptive information from each article. Abstracted data included article characteristics, description of study cohort, demographics for study cohort (e.g., mean age, sex, insurance), year(s) data were collected, locations of data collection, data source (e.g., Medicare, VA hospitals), purpose for data collection (e.g., hospital profiling, research study), number of black and white patients in the study, number of patients alive and dead at each follow-up period, unadjusted and adjusted OR (or HR) and confidence intervals for death in black patients compared with white patients, methods used for adjustment, and variables controlled for in adjusted analysis. Data were classified as “clinical” when data were obtained from patients’ medical records and as “administrative” otherwise. Because racial differences in hospital readmission rates could bias mortality rates, we examined whether studies used data that could track separate patient hospitalizations (i.e., readmissions). Data were abstracted by 2 statistical reviewers for 13 studies and agreement was 97% across data elements. The remaining 14 studies were abstracted by 1 of the statistical reviewers.

The primary outcome of the meta-analysis was all-cause mortality after hospitalization and was examined separately for unadjusted and adjusted data. Mortality data were stratified by several post-hospitalization follow-up intervals: in-hospital, 30-days, 60-180 days, 1 year, and after 1 year for unadjusted data, and short-term (0-30 days) and long-term (after 30 days) for adjusted data. Due to the general incompatibility of the OR and the HR, separate analyses were conducted for the adjusted OR and for the HR. Standard errors were calculated using the reported confidence interval for each result. When a study reported multiple results across different follow-up time intervals, we included the result for the longest duration of follow-up in the meta-analysis. A random effects model was used to analyze the data. To assess between-trial heterogeneity an I^2 was calculated. This statistic can range from 0-100% and describes the percentage of variability in point estimates that is due to between-trial heterogeneity rather than to chance, and is not dependent on the number of trials. There does not appear to be a gold standard for what is considered an acceptable I^2; however, we used an $I^2 < 30\%$ as an indicator of low (or mild) heterogeneity.

We conducted several analyses to examine the robustness of our findings. After constructing the final models, we examined a series of stratified meta-analyses by type of publication, data quality, data source for the study population (national, state, regional, hospital), demographic characteristics of patients (age, sex), year(s) data were collected, and length of follow-up. To further examine the stability of the findings, sensitivity analyses were conducted after removing studies with the largest or with the smallest sample sizes. Because of limitations in using a single method we examined whether publication bias exists within the data set by assessing funnel graph symmetry visually and statistically and by calculating a fail-safe N. Analyses were conducted using SAS (v9.2, Cary, NC) and Review Manager (RevMan v5.0 The Cochrane

Collaboration, Copenhagen). The VA Health Services Research and Development Service supported the review in part but had no role in the selection of articles or interpretation of results.

RESULTS

We identified 330 articles from our search strategy. From these we identified 95 potentially eligible articles and examined the full text of each article. Twenty-seven articles met the eligibility criteria,[1-27] and 2 of these articles reported multiple cohorts of hospitalized patients.[8, 21] This selection resulted in a total of 29 eligible cohorts. Of these 29 cohorts, 24 included both men and women and 9 excluded patients under the age of 65 years. Approximately half of the cohorts used a nationwide sample of patients, 10% were conducted at a single hospital, 17% used data from a single state, 44% were regional, multistate, or multihospital, 17% of cohorts were beneficiaries of the US Department of Veterans Affairs (VA), and 28% were Medicare/Medicaid beneficiaries. Table 1 includes a brief description of each cohort, the proportions of patients by race and gender, mean age within the cohort, and whether cohorts included readmissions. Mortality was adjusted for at least 1 covariate in all cohorts and 21 of 29 adjusted for 3 or more covariates. Cohorts adjusted black–white mortality outcomes using age (28 cohorts), gender (19 cohorts), socioeconomic status (9 cohorts), health insurance (5 cohorts), comorbidity (21 cohorts), clinical severity of illness (10 cohorts), and hospital-level factors (11 cohorts).

Unadjusted mean mortality rates after HF hospitalization for black and white patients, respectively, were 6% and 9% (in-hospital), 6% and 10% (30-day mortality), 10% and 15% (60-180 day mortality), 28% and 34% (1-year mortality), and 41% and 47% (mortality after 1 year). In the individual cohorts, unadjusted ORs were generally < 1.0 and in meta-analysis of the unadjusted data, the summary ORs were 0.58 (in-hospital), 0.59 (30-day), 0.69 (60-180 day), 0.71 (1-year), and 0.80 (after 1 year), indicating lower mortality after hospitalization in black

patients compared with white patients (Figure 1). A high level of heterogeneity was observed within each follow-up interval (I^2 range=61% to 99%), indicating substantial variability between cohorts. In a separate analysis cohorts contributing the highest amount of heterogeneity (as indicated by change in the group chi-square statistic) were eliminated systematically until I^2 was 30% or lower. After these changes were made, the unadjusted combined OR for mortality for black compared with white patients was 0.48 (95% CI 0.45-0.51) for 6 cohorts reporting in-hospital mortality, 0.62 (95% CI 0.60-0.65) for 8 cohorts reporting 30-day mortality, 0.71 (95% CI 0.66-0.76) for 2 cohorts reporting 60-180 day mortality, 0.68 (95% CI 0.65-0.72) for 4 cohorts reporting 1 year mortality, and 0.77 (95% CI 0.75-0.79) for 4 cohorts reporting deaths beyond 1 year.

We also conducted meta-analyses that combined results that were adjusted with potential risk factors for mortality. The adjusted meta-analyses were conducted separately for studies with short-term and long-term follow-up. Meta-analysis conducted using adjusted ORs for in-hospital or 30-day mortality resulted in a combined adjusted OR of 0.68 (95% CI 0.63-0.74; Figure 2a). Meta-analysis using HRs for follow-up intervals > 30-days resulted in a combined adjusted HR of 0.84 (95% CI 0.77-0.91; Figure 2b). These results indicate lower mortality in black compared with white patients after a hospitalization for HF for both short-term and long-term follow-up periods. However, heterogeneity was significant in both instances (I^2=79% and 68%, respectively). To reduce potential bias, we reexamined these meta-analyses after excluding 9 cohorts that (i) used data from the same source with overlapping time intervals (4 cohorts); (ii) increased the I^2 > 30% (2 cohorts); (iii) that explicitly included multiple admissions (2 cohorts), and (iv) that did not adjust for age (1 cohort). In these meta-analyses mortality was significantly lower in black compared with white patients, with a short-term OR of 0.74 (95% CI 0.70-0.79),

and a long-term HR of 0.84 (95%CI 0.78-0.91). Heterogeneity was low and not statistically significant for the short-term analysis (P=0.39 and I^2=5%), but remained high in the long-term (> 30-day to > 1 year mortality) analysis (P=0.002 and I^2=71%).

We conducted several stratified analyses to evaluate the robustness of our results. First, we examined the effect of data quality on results. We conducted stratified analyses according to whether the studies were able to identify and examine a single admission for each patient. Including readmissions could reduce reported mortality when readmissions are not uniformly distributed by race. The ORs for adjusted black-white mortality reported by studies examining single admissions, multiple admissions, and studies that did not identify whether readmissions were examined were 0.78 (95%CI 0.72–0.85), 0.73 (95%CI 0.68–0.79), and 0.67 (95%CI 0.61–0.72). Second, we examined changes in mortality when cohorts were systematically removed from the meta-analysis based on sample size. Changes observed were small. For example, starting with the short-term adjusted analysis (Figure 2a), additional analyses conducted after removal of the 3 largest studies resulted in an overall OR of 0.68 (95% CI 0.62–0.75), and after removal of the 3 smallest studies resulted in an OR of 0.71 (95% CI 0.66–0.76). Third, in stratified analyses by gender, the black-white OR for mortality was 0.66 (95% CI 0.60-0.73) in studies including only men, and 0.75 (95% CI 0.70–0.80) in studies with both men and women. Similarly, stratified analyses according to age, clinical or administrative classification, and year, source, location, and purpose of data collection showed significantly lower mortality in black compared with white patients. Finally, we found that publication bias was unlikely, given visually symmetrical and statistically non-significant funnel plots and a large fail-safe N of 3561.

DISCUSSION

In this analysis adjusted mortality was 32% lower in short-term follow–up and 16% lower in long-term follow–up for black patients compared with white patients after a hospitalization for HF. The lower mortality in black patients after hospitalization for HF was consistent in several stratified analyses, and in analyses according to study quality. It is likely that the lower mortality in black patients reflects, in part, racial differences in the utilization of hospital and ambulatory services, and racial differences in the pathophysiology, diagnosis, severity of illness, and response to treatment of hospitalized HF patients.

The lower mortality rates in black patients after HF hospitalization is surprising because of previous data from national and ambulatory cohorts indicating that HF death rates are higher or similar among blacks compared with whites.[29] For example, black patients had higher mortality in one cohort of almost 30,000 HF patients after 10 years of follow–up,[31] and no difference in mortality by race in a national sample of outpatient veterans with HF.[30] Comparing these results of higher or similar mortality in black patients in ambulatory cohorts with our result of lower mortality in black patients after hospitalization for HF highlights a paradox in HF mortality.

Potential explanations for the paradoxical mortality rates include differences by race in the quality of hospital care; in the use of hospital services; and in severity of illness at admission. Although the lower mortality in black patients might be explained if black patients had better quality of hospital care, studies have not reported overall better quality of hospital care for black compared with white patients,[23, 27, 28] and some report that blacks have worse quality of HF care.[32] In addition, studies report shorter,[1, 6, 16, 27] similar,[2, 9, 10, 18, 24] and higher[5, 19] length of stay (LOS) for black compared with white patients. So, differences in hospital (LOS) among black compared with white patients are unlikely to explain the consistent lower mortality in blacks

after hospitalization. Several studies also report that black patients have higher rates of hospital readmission for HF.[5, 7] In our meta-analysis, we found that the difference in mortality in black and white patients was attenuated when readmissions were excluded from the cohort. Nevertheless, mortality after hospitalization for HF remained lower in black compared with white patients even when a single admission was examined.

Moreover, previous research indicates that independent of readmissions, blacks have higher rates of hospital utilization for HF. Compared with whites, blacks have 1.3 to more than 2 times higher rates of hospital admission for HF, due in part to more common HF risk factors (e.g., hypertension).[8, 33] This higher reported rate of hospital utilization among black patients seems to be intertwined with the finding from previous research reporting lower severity of illness at admission among black compared with white patients. In hospitalized cohorts, black patients may have lower severity of illness compared with white patients if physicians' or hospitals' admitting thresholds are lower for black than for white patients, if adherence to pharmacologic or dietary therapies are lower among black patients[34] (who therefore respond quickly to inpatient treatment), if black patients have less access to routine ambulatory care services, or if black patients more commonly have HF risk factors such as hypertension[30] that may precipitate acute exacerbations more frequently and which may be more amenable to acute treatment. Alternatively, severity may be lower for black patients because white patients more commonly have risk factors for mortality that may not be modifiable in a hospitalization for HF (e.g., elevated cholesterol, coronary artery disease, and prior myocardial infarction).[33] Thus, differences by race in severity of illness at admission and hospital utilization may explain in part the lower mortality in black compared with white patients after a hospitalization for HF.

The results should be interpreted in the context of several limitations. First, when there was substantial heterogeneity between the studies, the combined estimates for mortality may not be useful summary measures. This limitation does not, however, diminish the overall robustness of the findings of lower mortality in black compared with white patients after hospitalization with HF. Second, the findings are dependent on how consistently the studies classified black and white race. Misclassification of race could have affected the magnitude of the mortality differences observed. Third, we did not evaluate other racial and ethnic groups, and thus our findings are not generalizable to other racial and ethnic groups. Finally, it is possible that our search criteria did not identify all the relevant articles for the meta–analysis. Nevertheless, the number of articles required to reverse the findings is large and it appears unlikely that the results were influenced by publication bias. Furthermore, although we excluded studies when data as reported could not be used in this meta–analysis, the findings of the excluded studies were consistent with our results.[35-37]

In conclusion, we found a consistently lower mortality rate among black compared with white patients after a hospitalization for HF. Explanations for the lower mortality rate among black patients are poorly understood and may include racial differences in hospital utilization, in physicians' diagnoses and admitting practices, in patients' access to health care services and health seeking behaviors, and in our ability to measure underlying risk factors that are associated with and lead to the development of acute decompensation of HF. Finally, the lower mortality rate among blacks in hospital cohorts differs from mortality in other cohorts and thus may influence comparative rankings of hospitals in quality reports or mortality profiles.

REFERENCES

1. Gordon HS, Harper DL, Rosenthal GE. Racial variation in predicted and observed in-hospital death. A regional analysis. *JAMA* 1996;276:1639-1644.
2. Deswal A, Petersen NJ, Souchek J, Ashton CM, Wray NP. Impact of race on health care utilization and outcomes in veterans with congestive heart failure. *J Am Coll Cardiol* 2004;43:778-784.
3. Agoston I, Cameron CS, Yao D, Dela RA, Mann DL, Deswal A. Comparison of outcomes of white versus black patients hospitalized with heart failure and preserved ejection fraction. *Am J Cardiol* 2004;94:1003-1007.
4. Ahmed A, Thornton P, Perry GJ, Allman RM, DeLong JF. Impact of atrial fibrillation on mortality and readmission in older adults hospitalized with heart failure. *Eur J Heart Fail* 2004;6:421-426.
5. 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;137:919-927.
6. Auble TE, Hsieh M, Yealy DM. Differences in initial severity of illness between black and white emergency department patients hospitalized with heart failure. *Am Heart J* 2009;157:306-311.
7. Brown DW, Haldeman GA, Croft JB, Giles WH, Mensah GA. Racial or ethnic differences in hospitalization for heart failure among elderly adults: Medicare, 1990 to 2000. *Am Heart J* 2005;150:448-454.
8. Croft JB, Giles WH, Pollard RA, Casper ML, Anda RF, Livengood JR. National trends in the initial hospitalization for heart failure. *J Am Geriatr Soc* 1997;45:270-275.

9. Croft JB, Giles WH, Pollard RA, Keenan NL, Casper ML, Anda RF. Heart failure survival among older adults in the United States: a poor prognosis for an emerging epidemic in the Medicare population. *Arch Intern Med* 1999;159:505-510.

10. Echols MR, Felker GM, Thomas KL, Pieper KS, Garg J, Cuffe MS, Gheorghiade M, Califf RM, O'Connor CM. Racial differences in the characteristics of patients admitted for acute decompensated heart failure and their relation to outcomes: results from the OPTIME-CHF trial. *J Card Fail* 2006;12:684-688.

11. Feinglass J, Martin GJ, Lin E, Johnson MR, Gheorghiade M. Is heart failure survival improving? Evidence from 2323 elderly patients hospitalized between 1989-2000. *Am Heart J* 2003;146:111-114.

12. Ibrahim SA, Cook CF, Kwoh CK, Rosenthal GE, Snow RJ, Harper DL, Baker DW. Racial differences in mortality among elderly patients admitted for heart failure. *Res Aging* 2001;23:457-472.

13. Ibrahim SA, Burant CJ, Kent KC. Elderly hospitalized patients with diastolic heart failure: lack of gender and ethnic differences in 18-month mortality rates. *J Gerontol A Biol Sci Med Sci* 2003;58:56-59.

14. Jha AK, Shlipak MG, Hosmer W, Frances CD, Browner WS. Racial differences in mortality among men hospitalized in the Veterans Affairs health care system. *JAMA* 2001;285:297-303.

15. Joshi AV, D'Souza AO, Madhavan SS. Differences in hospital length-of-stay, charges, and mortality in congestive heart failure patients. *Congest Heart Fail* 2004;10:76-84.

16. Kamath SA, Drazner MH, Wynne J, Fonarow GC, Yancy CW. Characteristics and outcomes in African American patients with decompensated heart failure. *Arch Intern Med* 2008;168:1152-1158.

17. McClellan WM, Flanders WD, Langston RD, Jurkovitz C, Presley R. Anemia and renal insufficiency are independent risk factors for death among patients with congestive heart failure admitted to community hospitals: a population-based study. *J Am Soc Nephrol* 2002;13:1928-1936.

18. Meyers JF, Robbins AS, Gildengorin GL, Grayson JK. Racial differences in mortality among men hospitalized in military hospitals. *Mil Med* 2008;173:539-543.

19. Philbin EF, DiSalvo TG. Influence of race and gender on care process, resource use, and hospital-based outcomes in congestive heart failure. *Am J Cardiol* 1998;82:76-81.

20. Pippins JR, Fitzmaurice GM, Haas JS. Hospital characteristics and racial disparities in hospital mortality from common medical conditions. *J Natl Med Assoc* 2007;99:1030-1036.

21. Polsky D, Lave J, Klusaritz H, Jha A, Pauly MV, Cen L, Xie H, Stone R, Chen Z, Volpp K. Is lower 30-day mortality posthospital admission among blacks unique to the Veterans Affairs health care system? *Med Care* 2007;45:1083-1089.

22. Polsky D, Jha AK, Lave J, Pauly MV, Cen L, Klusaritz H, Chen Z, Volpp KG. Short- and long-term mortality after an acute illness for elderly whites and blacks. *Health Serv Res* 2008;43:1388-1402.

23. Rathore SS, Foody JM, Wang Y, Smith GL, Herrin J, Masoudi FA, Wolfe P, Havranek EP, Ordin DL, Krumholz HM. Race, quality of care, and outcomes of elderly patients hospitalized with heart failure. *JAMA* 2003;289:2517-2524.

24. Shen JJ, Washington EL, Chung K, Bell R. Factors underlying racial disparities in hospital care of congestive heart failure. *Ethn Dis* 2007;17:206-213.

25. Volpp KG, Stone R, Lave JR, Jha AK, Pauly M, Klusaritz H, Chen H, Cen L, Brucker N, Polsky D. Is thirty-day hospital mortality really lower for black veterans compared with white veterans? *Health Serv Res* 2007;42:1613-1631.

26. Vaccarino V, Gahbauer E, Kasl SV, Charpentier PA, Acampora D, Krumholz HM. Differences between African Americans and whites in the outcome of heart failure: Evidence for a greater functional decline in African Americans. *Am Heart J* 2002;143:1058-1067.

27. Yancy CW, Abraham WT, Albert NM, Clare R, Stough WG, Gheorghiade M, Greenberg BH, O'Connor CM, She L, Sun JL, Young JB, Fonarow GC. Quality of care of and outcomes for African Americans hospitalized with heart failure: findings from the OPTIMIZE-HF (Organized Program to Initiate Lifesaving Treatment in Hospitalized Patients with Heart Failure) registry. *J Am Coll Cardiol* 2008;51:1675-1684.

28. Gordon HS, Johnson ML, Ashton CM. Process of care in Hispanic, black, and white VA beneficiaries. *Med Care* 2002;40:824-833.

29. Mortality from Congestive Heart Failure - United States, 1980-1990. *MMWR* 1994;43:77-81.

30. Deswal A, Petersen NJ, Urbauer DL, Wright SM, Beyth R. Racial variations in quality of care and outcomes in an ambulatory heart failure cohort. *Am Heart J* 2006;152:348-354.

31. McCullough PA, Philbin EF, Spertus JA, Kaatz S, Sandberg KR, Weaver WD. Confirmation of a heart failure epidemic: findings from the Resource Utilization Among Congestive Heart Failure (REACH) study. *J Am Coll Cardiol* 2002;39:60-69.

32. Ayanian JZ, Weissman JS, Chasan-Taber S, Epstein AM. Quality of care by race and gender for congestive heart failure and pneumonia. *Med Care* 1999;37:1260-1269.

33. Alexander M, Grumbach K, Selby J, Brown AF, Washington E. Hospitalization for congestive heart failure. Explaining racial differences. *JAMA* 1995;274:1037-1042.

34. Singh H, Gordon HS, Deswal A. Variation by race in factors contributing to heart failure hospitalizations. *J Card Fail* 2005;11:23-29.

35. Clarke SP, Davis BL, Nailon RE. Racial segregation and differential outcomes in hospital care. *West J Nurs Res* 2007;29:739-757.

36. Smith GL, Shlipak MG, Havranek EP, Masoudi FA, McClellan WM, Foody JM, Rathore SS, Krumholz HM. Race and renal impairment in heart failure: mortality in blacks versus whites. *Circulation* 2005;111:1270-1277.

37. Klapholz M, Maurer M, Lowe AM, Messineo F, Meisner JS, Mitchell J, Kalman J, Phillips RA, Steingart R, Brown EJ, Jr., Berkowitz R, Moskowitz R, Soni A, Mancini D, Bijou R, Sehhat K, Varshneya N, Kukin M, Katz SD, Sleeper LA, Le Jemtel TH. Hospitalization for heart failure in the presence of a normal left ventricular ejection fraction: results of the New York Heart Failure Registry. *J Am Coll Cardiol* 2004;43:1432-1438.

FIGURE LEGENDS

Figure 1 – Random effects meta-analyses in black compared with white patients with HF for unadjusted in-hospital mortality and for unadjusted mortality at 30-days, 60 to 180-days, 1 year, and after 1 year of follow-up. (Abbreviations CI = confidence interval, OR = odds ratio)

Figure 2a – Random effects meta-analysis in black compared with white patients with HF for adjusted short-term mortality (Abbreviations CI = confidence interval, OR = odds ratio)

Figure 2b – Random effects meta-analysis in black compared with white patients with HF for adjusted long-term mortality (Abbreviations CI = confidence interval, HR = hazard ratio)

TABLE 1 – Characteristics of cohorts included in the meta-analyses.

#	Author	Number of hospitalizations / description of data source or hospital(s)	% Black	% Female	Mean Age (years)	Multiple* Admissions
1	Agoston[3]	448 from 1 tertiary care VA hospital	44	1	68	0
2	Ahmed[4]	944 from 11 Alabama hospitals (Medicare)	18	61	79	+
3	Alexander[5]	76,466 from California hospitals	12	53	74	0
4	Auble[6]	8,668 from Pennsylvania hospitals	16	57	76	+
5	Brown[7]	6,491,495 from Medicare	11	-	-	-
6	Croft[8 (1997a)]	631,306 from Medicare	8	58	-	0
7	Croft[8 (1997b)]	803,506 from Medicare	8	58	-	0
8	Croft[9 (1999)]	170,239 from Medicare	9	58	79	0
9	Deswal[2]	21,994 from 153 VA hospitals	22	2	70	0
10	Echols[10]	923 from a research trial in 80 US hospitals	34	34	66	0
11	Feinglass[11]	2,323 from 1 Midwestern University hospital	17	54	-	0
12	Gordon[1]	24,833 from 30 northeast Ohio hospitals	23	56	73	-
13	Ibrahim[12 (2001)]	12,911 from 30 northeast Ohio hospitals	16	58	79	0
14	Ibrahim[13 (2003)]	1,058 from 30 northeast Ohio hospitals	13	70	79	-
15	Jha[14]	6,601 from 147 VA hospitals	22	0	64	0
16	Joshi[15]	14,603 from 1000 hospitals in 22 states	14	54	73	-
17	Kamath[16]	135,734 from 274 hospitals	22	52	73	+
18	McClellan[17]	665 from 1 southeastern state (Medicare)	28	60	76	0
19	Meyers[18]	2,101 from 54 US military hospitals	18	0	66	0
20	Philbin[19]	45,894 from 236 New York state hospitals	18	56	74	0
21	Pippins[20]	128,584 from 376 hospitals in 26 states	24	-	-	-
22	Polsky[21 (2007a)†]	104,493 from 138 VA hospitals.	25	0	68	-
23	Polsky[21 (2007b)†]	371,622 from hospitals in 2 states	14	0	69	-
24	Polsky[22 (2008)]	1,855,844 from Medicare	11	59	80	0

TABLE 1 – continued

#	Author	Number of hospitalizations / description of data source or hospital(s)	% Black	% Female	Mean Age (years)	Multiple* Admissions
25	Rathore[23]	29,732 from National HF Project	12	60	80	0
26	Shen[24]	373,158 from 20% of US hospital discharges	13	51	70	-
27	Vaccarino[26]	398 from Yale New Haven hospital	21	52	73	0
28	Volpp[25]	111,556 from 138 VA hospitals	25	0	69	+
29	Yancy[27]	47,189 from OPTIMIZE-HF national registry	18	52	73	0

Notes:

* The symbol '+' denotes multiple admissions; '0' denotes only single admissions per individual; and '-' denotes that information about multiple admissions could not be determined.

† Published data were stratified by <65 or ≥65 years of age.

VA United States Department of Veterans Affairs

Figure 1

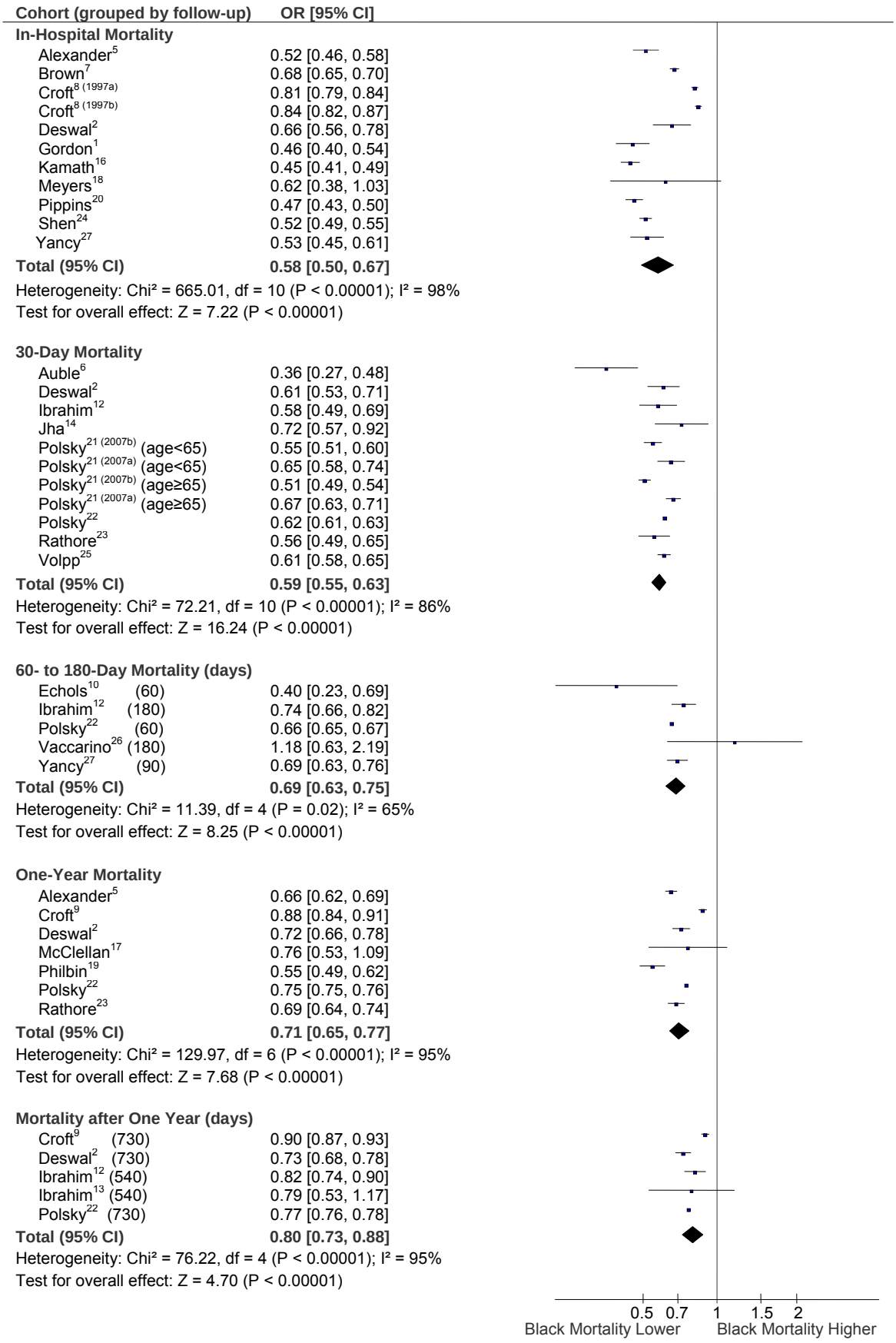
Cohort (grouped by follow-up) OR [95% CI]
In-Hospital Mortality
Alexander[5] 0.52 [0.46, 0.58]
Brown[7] 0.68 [0.65, 0.70]
Croft[8] (1997a) 0.81 [0.79, 0.84]
Croft[8] (1997b) 0.84 [0.82, 0.87]
Deswal[2] 0.66 [0.56, 0.78]
Gordon[1] 0.46 [0.40, 0.54]
Kamath[16] 0.45 [0.41, 0.49]
Meyers[18] 0.62 [0.38, 1.03]
Pippins[20] 0.47 [0.43, 0.50]
Shen[24] 0.52 [0.49, 0.55]
Yancy[27] 0.53 [0.45, 0.61]
Total (95% CI) 0.58 [0.50, 0.67]
Heterogeneity: Chi² = 665.01, df = 10 (P < 0.00001); I² = 98%
Test for overall effect: Z = 7.22 (P < 0.00001)
30-Day Mortality
Auble[6] 0.36 [0.27, 0.48]
Deswal[2] 0.61 [0.53, 0.71]
Ibrahim[12] 0.58 [0.49, 0.69]
Jha[14] 0.72 [0.57, 0.92]
Polsky[21] (2007b) (age<65) 0.55 [0.51, 0.60]
Polsky[21] (2007a) (age<65) 0.65 [0.58, 0.74]
Polsky[21] (2007b) (age≥65) 0.51 [0.49, 0.54]
Polsky[21] (2007a) (age≥65) 0.67 [0.63, 0.71]
Polsky[22] 0.62 [0.61, 0.63]
Rathore[23] 0.56 [0.49, 0.65]
Volpp[25] 0.61 [0.58, 0.65]
Total (95% CI) 0.59 [0.55, 0.63]
Heterogeneity: Chi² = 72.21, df = 10 (P < 0.00001); I² = 86%
Test for overall effect: Z = 16.24 (P < 0.00001)
60- to 180-Day Mortality (days)
Echols[10] (60) 0.40 [0.23, 0.69]
Ibrahim[12] (180) 0.74 [0.66, 0.82]
Polsky[22] (60) 0.66 [0.65, 0.67]
Vaccarino[26] (180) 1.18 [0.63, 2.19]
Yancy[27] (90) 0.69 [0.63, 0.76]
Total (95% CI) 0.69 [0.63, 0.75]
Heterogeneity: Chi² = 11.39, df = 4 (P = 0.02); I² = 65%
Test for overall effect: Z = 8.25 (P < 0.00001)
One-Year Mortality
Alexander[5] 0.66 [0.62, 0.69]
Croft[9] 0.88 [0.84, 0.91]
Deswal[2] 0.72 [0.66, 0.78]
McClellan[17] 0.76 [0.53, 1.09]
Philbin[19] 0.55 [0.49, 0.62]
Polsky[22] 0.75 [0.75, 0.76]
Rathore[23] 0.69 [0.64, 0.74]
Total (95% CI) 0.71 [0.65, 0.77]
Heterogeneity: Chi² = 129.97, df = 6 (P < 0.00001); I² = 95%
Test for overall effect: Z = 7.68 (P < 0.00001)
Mortality after One Year (days)
Croft[9] (730) 0.90 [0.87, 0.93]
Deswal[2] (730) 0.73 [0.68, 0.78]
Ibrahim[12] (540) 0.82 [0.74, 0.90]
Ibrahim[13] (540) 0.79 [0.53, 1.17]
Polsky[22] (730) 0.77 [0.76, 0.78]
Total (95% CI) 0.80 [0.73, 0.88]
Heterogeneity: Chi² = 76.22, df = 4 (P < 0.00001); I² = 95%
Test for overall effect: Z = 4.70 (P < 0.00001)
0.5 0.7 1 1.5 2
Black Mortality Lower
Black Mortality Higher

Figure 2a

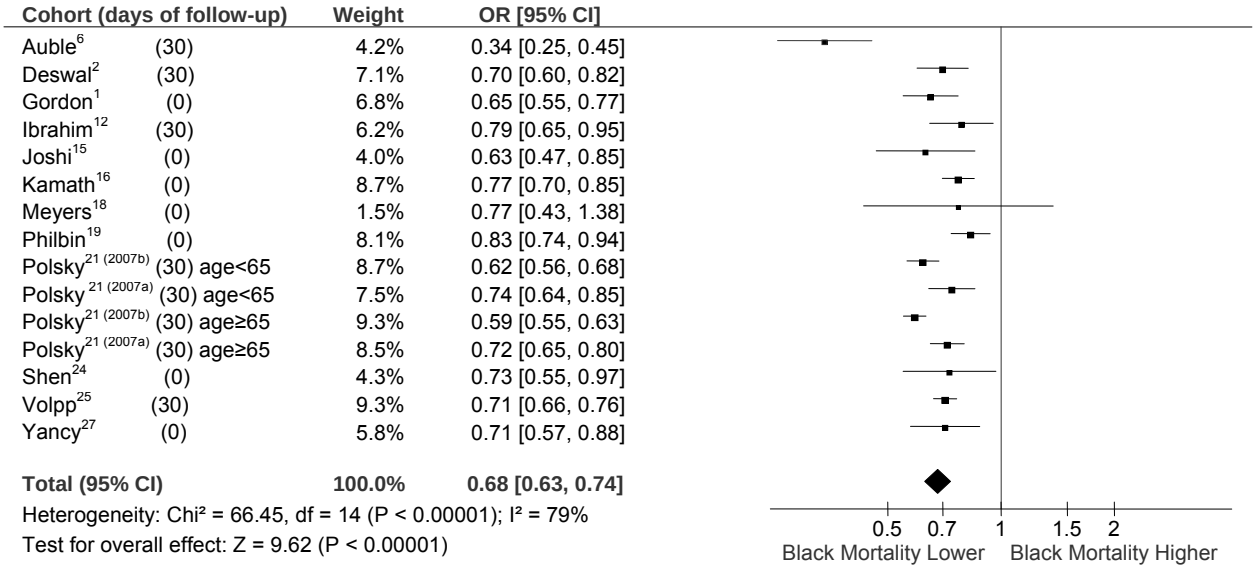
Cohort (days of follow-up)
Weight
OR [95% CI]
Auble[6] (30) 4.2% 0.34 [0.25, 0.45]
Deswal[2] (30) 7.1% 0.70 [0.60, 0.82]
Gordon[1] (0) 6.8% 0.65 [0.55, 0.77]
Ibrahim[12] (30) 6.2% 0.79 [0.65, 0.95]
Joshi[15] (0) 4.0% 0.63 [0.47, 0.85]
Kamath[16] (0) 8.7% 0.77 [0.70, 0.85]
Meyers[18] (0) 1.5% 0.77 [0.43, 1.38]
Philbin[19] (0) 8.1% 0.83 [0.74, 0.94]
Polsky[21 (2007b)] (30) age<65 8.7% 0.62 [0.56, 0.68]
Polsky[21 (2007a)] (30) age<65 7.5% 0.74 [0.64, 0.85]
Polsky[21 (2007b)] (30) age≥65 9.3% 0.59 [0.55, 0.63]
Polsky[21 (2007a)] (30) age≥65 8.5% 0.72 [0.65, 0.80]
Shen[24] (0) 4.3% 0.73 [0.55, 0.97]
Volpp[25] (30) 9.3% 0.71 [0.66, 0.76]
Yancy[27] (0) 5.8% 0.71 [0.57, 0.88]
Total (95% CI) 100.0% 0.68 [0.63, 0.74]
Heterogeneity: Chi² = 66.45, df = 14 (P < 0.00001); I² = 79%
Test for overall effect: Z = 9.62 (P < 0.00001)
0.5
0.7
1
1.5
2
Black Mortality Lower
Black Mortality Higher

Figure 2b

Cohort (days of follow-up)	Weight	HR [95% CI]
Agoston[3] (1825)	6.1%	0.73 [0.55, 0.97]
Ahmed[4] (1460)	3.6%	0.71 [0.48, 1.05]
Alexander[5] (365)	30.3%	0.86 [0.82, 0.90]
Croft[9] (1800)	32.6%	0.91 [0.89, 0.94]
Echols[10] (60)	0.5%	0.50 [0.17, 1.47]
Feinglass[11] (4650)	14.9%	0.69 [0.59, 0.80]
McClellan[17] (1000)	7.4%	0.81 [0.63, 1.04]
Yancy[27] (90)	4.6%	1.12 [0.80, 1.57]
Total (95% CI)	**100.0%**	**0.84 [0.77, 0.91]**

Heterogeneity: Chi² = 21.76, df = 7 (P = 0.003); I² = 68%

Test for overall effect: Z = 4.42 (P < 0.0001)