National Differences in Trends for Heart Failure Hospitalizations by Sex and Race/Ethnicity

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Background—National heart failure (HF) hospitalization rates have not been appropriately age standardized by sex or race/ethnicity. Reporting hospital utilization trends by subgroup is important for monitoring population health and developing interventions to eliminate disparities.

Methods and Results—The National Inpatient Sample (NIS) was used to estimate the crude and age-standardized rates of HF hospitalization between 2002 and 2013 by sex and race/ethnicity. Direct standardization was used to age-standardize rates to the 2000 US standard population. Relative differences between subgroups were reported. The national age-adjusted HF hospitalization rate decreased 30.8% from 526.86 to 364.66 per 100 000 between 2002 and 2013. Although hospitalizations decreased for all subgroups, the ratio of the age-standardized rate for men compared with women increased from 20% greater to 39% (*P* trend=0.002) between 2002 and 2013. Black men had a rate that was 229% (*P* trend=0.141) and black women, 240% (*P* trend=0.725) with reference to whites in 2013 with no significant change between 2002 and 2013. Hispanic men had a rate that was 32% greater in 2002 and the difference narrowed to 4% (*P* trend=0.047) greater in 2013 relative to whites. For Hispanic women, the rate was 55% greater in 2002 and narrowed to 8% greater (*P* trend=0.004) in 2013 relative to whites. Asian/Pacific Islander men had a 27% lower rate in 2002 that improved to 43% (*P* trend=0.040) lower in 2013 relative to whites. For Asian/Pacific Islander women, the hospitalization rate was 24% lower in 2002 and improved to 43% (*P* trend=0.021) lower in 2013 relative to whites.

Conclusions—National HF hospitalization rates have decreased steadily during the recent decade. Disparities in HF burden and hospital utilization by sex and race/ethnicity persist. Significant population health interventions are needed to reduce the HF hospitalization burden among blacks. An evaluation of factors explaining the improvements in the HF hospitalization rates among Hispanics and Asian/Pacific Islanders is needed. **(*Circ Cardiovasc Qual Outcomes*. 2017;10:e003552. DOI: 10.1161/CIRCOUTCOMES.116.003552.)**

Key Words: comorbidity ■ healthcare disparities ■ heart failure ■ hospitalization ■ population groups ■ population surveillance ■ public health

Heart failure (HF) is the fourth leading cause of hospitalization and the leading cause of hospitalization for cardiovascular conditions in the United States.[1] Among adults aged >85 years, HF is the number one cause of hospitalization.[1] The total number of primary HF hospitalizations per year in the United States has been steady at ≈1 million for the past decade.[2,3] In 2012, an ≈5.7 million American adults had HF based on self-report.[2] By 2030, the prevalence of HF is expected to increase 46% to >8 million people secondary to an aging demographic nationally.[4] However, national prevalence estimates based on self-report are likely lower than the true HF prevalence because 31% to 57% of patients underreport a HF diagnosis.[5,6] The prevalence of HF is also not equally distributed by sex and race/ethnicity.[7] Projected total costs for HF medical care are expected to increase from $20.9 billion in 2012 to $53.1 billion in 2030 with 80% of expenditures attributed to hospitalization.[4] Approximately 80% of the medical costs related to HF result from inpatient hospital care.[4] The Affordable Care Act prioritizes the containment of hospitalization costs, and whether preventable hospitalizations will be reduced secondary to the expanded insurance markets needs to be observed.[8]

Limited data exist on the trends and differential HF hospitalization rates by sex and race/ethnicity, particularly when applying appropriate statistical age standardization. Demographically standardized hospitalization rates are a useful marker of differences in the HF hospitalization burden. Subgroups defined by race/ethnicity, sex, socioeconomic status, and region are disproportionally burdened by cardiovascular

Received January 6, 2017; accepted May 15, 2017.

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The Data Supplement is available at http://circoutcomes.ahajournals.org/lookup/suppl/doi:10.1161/CIRCOUTCOMES.116.003552/-/DC1.

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WHAT IS KNOWN

- The burden of cardiovascular disease is known to be higher among blacks compared with whites, but differences in HF hospitalizations based on sex and racial/ethnic categorization, with appropriate age standardization, are not well described.

WHAT THE STUDY ADDS

- HF hospitalization disparities are greater for minorities when appropriately age standardized.
- The burden of HF hospitalizations is significantly higher for blacks when compared with whites with little change in the relative disparity over the past 12 years of observation.
- Hispanics have a higher HF hospitalization rate with a narrowing of disparities over the same period of observation, whereas Asians have a significantly lower rate of HF hospitalizations that has been stable.
- Significant population health interventions are needed to reduce the HF hospitalization burden.

diseases and HF.[9] Population differences in cardiovascular risk factors, access to care, and insufficient public health efforts underlie measured differences in HF burden.[10] A standardized marker of health differences assists in targeting interventions toward vulnerable populations and monitoring the response to interventions over time. We analyzed the National Inpatient Sample (NIS), an all-payer data set that represents acute-care hospital utilization nationally, to estimate the age-standardized rates for adult HF hospitalizations and relative differences by sex and race/ethnicity between 2002 and 2013.

Methods

Data Sources

The NIS data set provides hospital administrative data through the Healthcare Research and Quality Healthcare Cost and Utilization Project. The NIS datasets were obtained for the years 2002 to 2013. Each year of the NIS contains a sample of 7 to 8 million hospital discharges. The NIS redesigned its sampling strategy in 2012 to improve national estimates. Before 2012, the NIS sampled approximately all hospitalization records from 1000 hospitals (a 20% hospital sample). After 2012, the NIS sampled 20% of all records from ≈4300 participating hospitals. Additionally, long-term acute-care hospitals were excluded beginning with the 2012 NIS. The redesign's exclusion of long-term acute-care hospitals decreased the total number of discharges by 0.7%. Trend weights were applied for 2002 to 2011 data set to account for shifts in sampling strategy. Trend weights for 2012 and 2013 are not currently available, and recommended standard weights were used. The unit of analysis in the NIS is a discharge; therefore, readmissions are not identified. The NIS sampling frame covers >95% of the US population and 94% of all community hospital discharges.[11]

Study Cohort

HF was defined by any *International Classification of Diseases-Ninth Revision*–clinical modification code (Table I in the Data Supplement) that mentioned a HF syndrome. A primary HF hospitalization was defined as any HF *International Classification of Diseases-Ninth Revision*–clinical modification discharge code used as the first listed discharge code. Patients <18 years were excluded. The definition used for a primary HF admission is consistent with prior publications.[3,12] Race/ethnicity was classified as white, black, Hispanic, Asian or Pacific Islander (PI), or Native American as captured by administrative hospital data. Native Americans were not included in the study because of their small sample size and unreliable estimates.

Statistical Analysis

Within the NIS, racial/ethnic classification was missing for ≈27.5% of the sample in 2002. Race/ethnicity coding improved in more recent years with 4.6% missing in the 2013 NIS. The missing racial/ethnic data are unlikely to be missing completely at random. Certain states in the early years of the NIS are known to have withheld racial/ethnic classification. For all NIS datasets, missing race/ethnicity was imputed using a multinomial logistic model using age, sex, insurance status, comorbid conditions, hospital region, and characteristics. This method adheres to the recommendations provided by Healthcare Cost and Utilization Project for handling missing racial/ethnic data.[13] Calculating HF hospitalization rates by race/ethnicity would be significantly underestimated without imputation. The primary purpose of the imputation was to normalize population-based estimates and not reliably identify the racial/ethnic classification for any single HF hospitalization.

United States Census estimates were used for each sex and racial/ethnic subgroup to calculate crude and age-standardized rates per 100 000 people. For each year of the NIS, the number of adult HF hospitalizations per single-year of life were estimated by sex and race/ethnicity. HF hospitalization rates were age standardized for the 2000 US standard population using the direct standardization method. Direct standardization used single-year of life age adjustments to limit any residual bias-related shifts in the age distribution within subgroups. Variance estimation used modified γ intervals.[14] Statistical significance for the hospitalization rate trend analysis used a nonparametric Wilcoxon-type rank-sum test.[15] All estimation procedures were performed with the appropriate NIS survey weights to account for the sampling strategy in STATA 13.1 (StataCorp, College Station, TX). Descriptive statistics are provided for patient characteristics, select comorbidities, hospital length of stay, and inpatient mortality. Institutional review board provided exemption for this project.

Results

HF Hospitalizations, Mortality, and Patient Characteristics

Between 2002 and 2013, there were an ≈12 783 478 primary HF hospitalizations nationally. The average age was ≈72 years nationally, the proportion of minority patients increased over time, and select comorbidities were generally more frequent in later years (Table 1; Table III in the Data Supplement). The mean length of stay decreased slightly from 5.59 to 5.28 days between 2002 and 2013, whereas the crude and age-standardized rates for inpatient mortality improved modestly (Figure 1). The difference in the mean length of stay between subgroups is minimal (Figure IA and IB in the Data Supplement). Inpatient mortality is higher for whites when compared with other subgroups, and the difference is decreased when age adjusted (Figure IIA and IIB in the Data Supplement). The average age at hospitalization was ≈75 years for women, 70 for men, 75 for whites, 63 for blacks, 69 for Hispanics, and 72 for Asians/PI (Table II in the Data Supplement). The total number of national HF hospitalizations decreased 14.4% from 1 122 064 in 2002 to 960 124 in 2013 (Table 2). The national crude HF hospitalization rate decreased 24.2% from 522.49 per 100 000 in 2002 to 395.86 in 2013 (Figure IIIA and Table VIII in the Data Supplement). The national age-standardized HF hospitalization rate fell 30.8% (average 3.3% per year) from 526.86 in 2002 to 364.66 per 100 000 in 2013 (Figure

Table 1. Baseline Characteristics for the National Heart Failure Cohort for Select Years 2002, 2007, and 2013 From the National Inpatient Sample

	2002	2007	2013
Age, y	72.90	72.48	72.27
Women, %	54.74	51.34	49.03
Race/ethnicity, %			
White	70.40	66.55	64.34
Black	18.01	20.09	19.23
Hispanic	7.13	7.82	7.37
Asian/PI	1.59	1.80	1.91
Census region, %			
New England	4.77	6.56	4.98
Mid Atlantic	16.30	13.09	15.03
East North Central	16.42	18.48	16.75
West North Central	7.23	6.06	6.18
South Atlantic	26.30	25.06	21.92
East South Central	5.95	4.48	7.69
West South Central	7.92	10.43	11.30
Mountain	2.03	3.66	4.19
Pacific	13.08	12.17	11.96
Primary payer, %			
Medicare	76.35	74.11	74.85
Medicaid	6.56	7.46	8.08
Private insurance	13.11	12.78	11.08
Self-pay	2.29	3.29	3.48
No charge	0.21	0.41	0.38
Other	1.42	1.80	2.00
Comorbidities*, %			
HTN	58.73	65.39	70.92
CAD	27.49	29.54	32.23
Atrial fibrillation	12.94	15.20	17.77
Obese	18.72	20.18	32.40
Valve disease	16.80	19.82	22.29
VT	5.09	6.08	7.14
AMI	1.68	1.89	2.28
PVD	4.14	4.88	6.60
DM	33.23	35.22	38.81
COPD	17.31	17.65	17.74
Anemia	19.17	22.42	30.01
Fluid/electrolyte	19.10	24.12	31.87

AMI indicates acute myocardial infarction; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; HTN, hypertension; PI, Pacific Islander; PVD, peripheral vascular disease; and VT, ventricular tachycardia.

*Age-standardized proportions to 2000 US standard population.

IIIB in the Data Supplement). The national male age-standardized HF hospitalization rate decreased 25.8% from 581.69 in 2002 to 431.40 per 100 000 in 2013. Women had a 36.0% decrease in the age-standardized HF hospitalization rate from 486.20 in 2002 to 310.99 per 100 000 in 2013. With respect to disposition at discharge, the proportion of patients discharged to home remained relatively constant, whereas the proportion discharged to skilled nursing and intermediate care facilities increased (Table IV, V, and VI in the Data Supplement).

HF Hospitalizations by Race/Ethnicity

After imputation for missing race/ethnicity data, the crude hospitalization rate for Hispanics was noted to be lower than whites (Figure 2; Figure IVA in the Data Supplement). Imputation for missing racial/ethnic classification did not considerably shift the proportional representation of each racial/ethnic group in the sample (Table VII in the Data Supplement). Hispanics have a higher hospitalization rate than whites when age standardized (Figure 2B; Figure IVB in the Data Supplement). The age-standardized HF hospitalization rate decreased 29.6% for whites from 448.29 in 2002 to 315.69 per 100 000 in 2013. For blacks, the age-standardized HF hospitalization rate decreased 29.4% from 1048.31 in 2002 to 739.72 per 100 000 in 2013. Hispanics had a greater 48.4% decrease in age-standardized HF hospitalization rate 649.53 in 2002 to 335.41 per 100,000 in 2013. For Asian/PI, the age-standardized HF hospitalization rate decreased 47.5% from 342.85 in 2002 to 179.90 per 100 000 in 2013.

When comparing sex within racial/ethnic subgroups, the age-standardized HF hospitalization rate for men is uniformly higher than the rate for women across all groups except for Hispanics in the 2005 NIS (Figure 2B). The 2005 NIS had a lower representation of all racial/ethnic minority groups, and the rate of hospitalization was higher for Hispanic women compared with men. The difference in age-standardized hospitalization rates between men and women was greatest for blacks followed by whites, Hispanic, and Asians/PI.

Relative Differences in HF Hospitalization Rates

The crude HF hospitalization rates generally reveal a smaller difference between subgroups. The ratio of the age-standardized HF hospitalization rate for men compared with women increased from 20% greater to 39% between 2002 and 2013 (P trend=0.002), and the absolute difference in rate was mostly unchanged (P trend=0.870; Table 3). Black men had a rate that was 229% (P trend=0.141) and black women 240% (P trend=0.725) referenced to whites in 2013 with no significant change between 2002 and 2013. Hispanic men had a rate that was 32% greater in 2002, and the relative difference narrowed to 4% (P trend=0.047) greater in 2013 relative to whites. Similarly, for Hispanic women, the rate was 55% greater in 2002 and narrowed to 8% greater (P trend=0.004) in 2013 relative to whites. Asian/PI men had a 27% lower rate in 2002 that improved to 43% (P trend=0.040) lower in 2013 relative to whites. Similarly, for Asian/PI women, the hospitalization rate was 24% lower in 2002 and improved to 43% (P trend=0.021) lower in 2013 relative to whites. Relative differences between female minority groups and whites mirrored the differences reported between male subgroups.

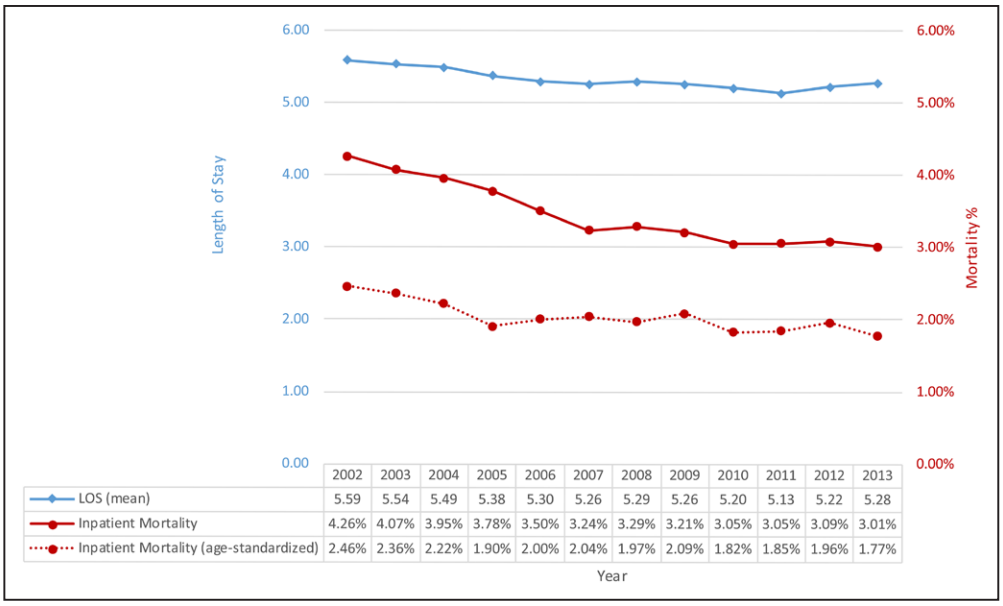


Figure 1. Trends in national heart failure hospitalization length of stay and inpatient mortality from the National Inpatient Sample. Age standardized to the 2000 US standard population. LOS indicates length of stay.

Discussion

Overall, we find positive and reassuring findings that hospital utilization for HF is decreasing nationally when adjusting for the aging population. The age-standardized primary HF hospitalization rate has decreased steadily between 2002 and 2013 in the United States. This suggests that improvements in the outpatient management of HF and the expansion of evidenced-based medical and device therapies may have lowered the national hospitalization burden. Moreover, the decreasing hospitalization rate likely correlates with a lower age-standardized prevalence of HF from gains in the primary prevention of cardiovascular disease between 2002 and 2013. Despite these overall improvements, the HF hospitalization burden for men has increased relative to women. In addition, the high HF hospitalization ratio among blacks relative to whites has not decreased during the recent decade, whereas Hispanics and Asian/PI more rapidly reduced their HF hospitalization rates relative to whites.

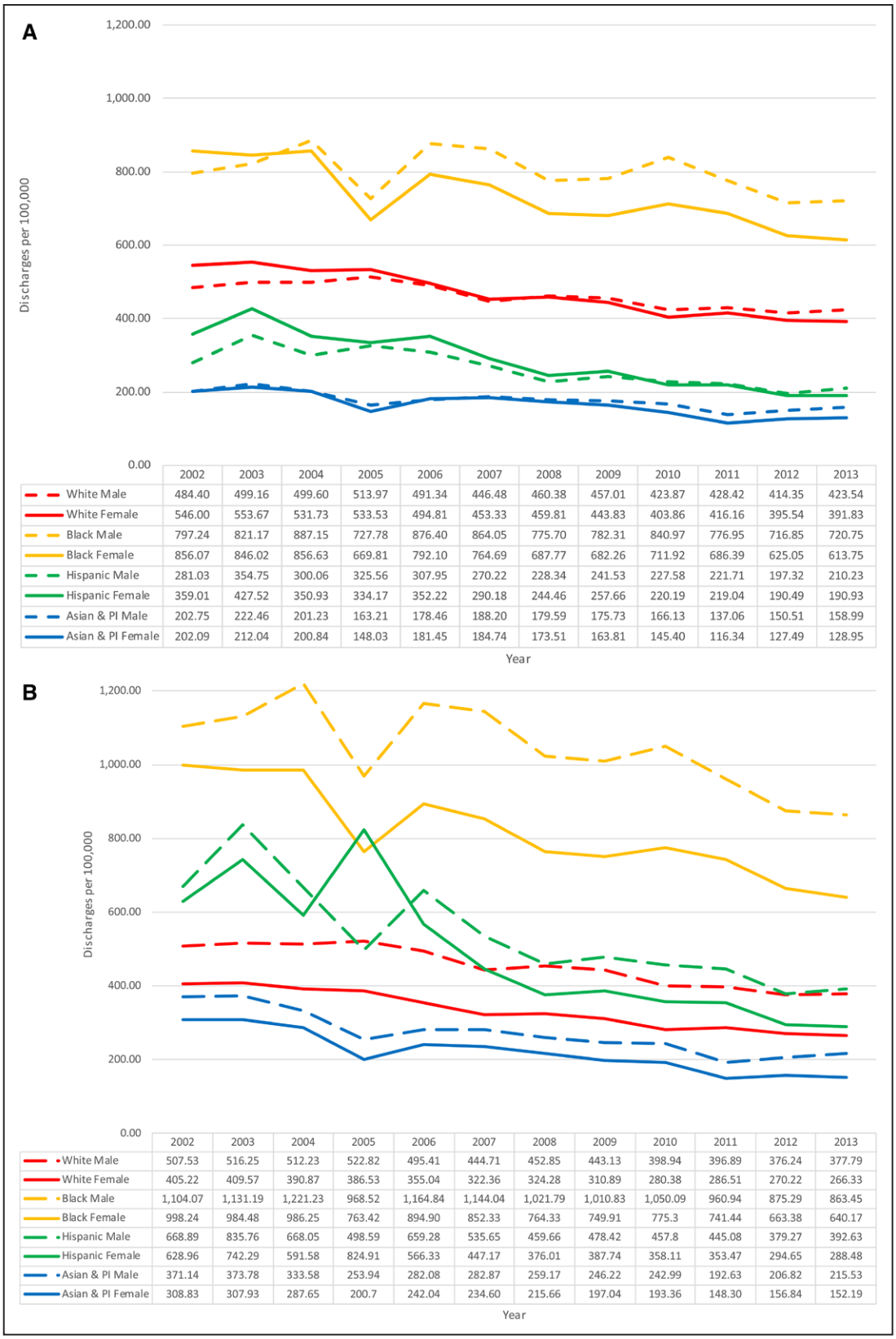
The decline in the national age-standardized HF hospitalization rate is generally consistent with prior observational studies. The crude national hospitalization rate of HF was estimated to decline 26.9% between 2001 and 2009.[12] Using Medicare administrative data, the crude rate of hospitalization decreased 31.2% from 2845 per 100 000 person-years in 1998 to 1957 per 100 000 person-years in 2008.[16] Crude rates are helpful in measuring per capita hospitalization utilization, whereas age-standardized rates allow for accurate subgroup comparisons and remove age-related bias when trending rates over time. Prior research reporting the national HF hospitalization trends using the NIS were limited and did not follow the Center for Disease Control age-adjustment recommendations.[3,12,17]

Both crude and age-standardized inpatient mortality rates improved nationally despite more prevalent comorbid conditions and minimal decreases in length of stay. The lower inpatient mortality rates suggest progressive improvement in the hospital management of primary HF admissions. Whites experience a higher inpatient mortality when compared with other race/ethnic groups that may reflect a comparatively higher burden of admissions with later stages of disease.

Table 2. Absolute Number of Heart Failure Hospitalizations Per Year From 2002 to 2013 From the National Inpatient Sample

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
National	1 122 064	1 170 708	1 154 020	1 127 778	1 133 112	1 061 987	1 050 087	1 051 715	997 224	1 003 419	951 220	960 124
Sex												
Men	507 777	536 711	541 949	539 530	548 631	516 532	513 538	521 006	499 459	497 152	476 925	489 180
Women	614 212	633 783	611 809	588 049	584 403	545 263	536 380	530 635	497 751	506 188	474 275	470 760
Race												
White	789 931	810 712	797 887	814 026	770 023	706 717	726 624	714 236	651 953	668 969	642 535	648 730
Black	202 068	206 212	218 580	177 492	215 143	213 375	195 084	198 172	213 006	204 510	190 595	192 290
Hispanic	79 959	101 268	87 227	88 380	94 629	83 098	724 555	78 944	75 192	76 159	68 885	73 210
Asian/PI	17 884	19 202	18 924	15 154	17 994	19 165	18 640	18 357	18 450	15 525	17 640	18 905

PI indicates Pacific Islander.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
White Male	484.40	499.16	499.60	513.97	491.34	446.48	460.38	457.01	423.87	428.42	414.35	423.54
White Female	546.00	553.67	531.73	533.53	494.81	453.33	459.81	443.83	403.86	416.16	395.54	391.83
Black Male	797.24	821.17	887.15	727.78	876.40	864.05	775.70	782.31	840.97	776.95	716.85	720.75
Black Female	856.07	846.02	856.63	669.81	792.10	764.69	687.77	682.26	711.92	686.39	625.05	613.75
Hispanic Male	281.03	354.75	300.06	325.56	307.95	270.22	228.34	241.53	227.58	221.71	197.32	210.23
Hispanic Female	359.01	427.52	350.93	334.17	352.22	290.18	244.46	257.66	220.19	219.04	190.49	190.93
Asian & PI Male	202.75	222.46	201.23	163.21	178.46	188.20	179.59	175.73	166.13	137.06	150.51	158.99
Asian & PI Female	202.09	212.04	200.84	148.03	181.45	184.74	173.51	163.81	145.40	116.34	127.49	128.95

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
White Male	507.53	516.25	512.23	522.82	495.41	444.71	452.85	443.13	398.94	396.89	376.24	377.79
White Female	405.22	409.57	390.87	386.53	355.04	322.36	324.28	310.89	280.38	286.51	270.22	266.33
Black Male	1,104.07	1,131.19	1,221.23	968.52	1,164.84	1,144.04	1,021.79	1,010.83	1,050.09	960.94	875.29	863.45
Black Female	998.24	984.48	986.25	763.42	894.90	852.33	764.33	749.91	775.3	741.44	663.38	640.17
Hispanic Male	668.89	835.76	668.05	498.59	659.28	535.65	459.66	478.42	457.8	445.08	379.27	392.63
Hispanic Female	628.96	742.29	591.58	824.91	566.33	447.17	376.01	387.74	358.11	353.47	294.65	288.48
Asian & PI Male	371.14	373.78	333.58	253.94	282.08	282.87	259.17	246.22	242.99	192.63	206.82	215.53
Asian & PI Female	308.83	307.93	287.65	200.7	242.04	234.60	215.66	197.04	193.36	148.30	156.84	152.19

Figure 2. A, National crude hospitalization rate by race/ethnicity and sex from the National Inpatient Sample (NIS). **B**, National age-standardized hospitalization rate by race/ethnicity and sex from the NIS. PI indicates Pacific Islander.

Although inpatient mortality rates have decreased, the proportion of patients discharged to home was relatively constant and the proportion discharged to skilled nursing or intermediate facilities increased. One in 5 hospitalized HF patients were discharged to an extended care facility, which is associated with a greater risk of death and readmission when controlling

Table 3. Measures of Difference in the Age-Standardized Heart Failure Hospitalization Rate by Sex and Race/Ethnicity From the National Inpatient Sample

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	*P* trend
Men*													
Ratio	1.20 (1.19–1.20)	1.21 (1.21–1.22)	1.26 (1.26–1.27)	1.31 (1.31–1.32)	1.33 (1.33–1.34)	1.34 (1.33–1.34)	1.35 (1.35–1.36)	1.37 (1.37–1.38)	1.37 (1.37–1.38)	1.34 (1.34–1.34)	1.36 (1.35–1.36)	1.39 (1.38–1.39)	0.002
Excess	95.49 (93.43–97.55)	105.70 (103.64–107.76)	123.58 (121.56–125.60)	138.93 (136.98–140.88)	144.34 (142.41–146.27)	133.12 (131.30–134.94)	134.54 (132.76–136.32)	138.41 (136.67–140.15)	129.14 (127.47–130.81)	117.88 (116.24–119.52)	113.93 (112.37–115.49)	120.32 (118.79–121.85)	0.870
Men†													
Black													
Ratio	2.18 (2.17–2.18)	2.19 (2.18–2.20)	2.38 (2.38–2.39)	1.85 (1.84–1.86)	2.35 (2.34–2.36)	2.57 (2.57–2.58)	2.26 (2.25–2.26)	2.28 (2.27–2.29)	2.63 (2.62–2.64)	2.42 (2.41–2.43)	2.33 (2.32–2.33)	2.29 (2.28–2.29)	0.141
Excess	596.54 (588.61–604.47)	614.94 (606.96–622.92)	709.00 (700.74–717.26)	445.70 (438.48–452.92)	669.43 (661.58–677.28)	699.33 (691.03–707.03)	568.94 (561.72–576.16)	567.70 (560.68–574.72)	651.15 (644.21–658.09)	564.05 (557.51–570.59)	499.05 (492.93–505.17)	485.66 (479.69–491.63)	0.112
Hispanic													
Ratio	1.32 (1.31–1.33)	1.62 (1.61–1.63)	1.30 (1.29–1.32)	0.95 (0.94–0.96)	1.33 (1.32–1.34)	1.20 (1.19–1.22)	1.02 (1.00–1.03)	1.08 (1.07–1.09)	1.15 (1.14–1.16)	1.12 (1.11–1.13)	1.01 (1.00–1.02)	1.04 (1.03–1.05)	0.047
Excess	161.36 (153.68–169.04)	319.51 (311.18–327.84)	155.82 (148.67–162.97)	−24.23 (−29.312 to −19.14)	163.87 (157.14–170.60)	90.94 (85.17–96.71)	6.81 (1.53–12.09)	35.29 (30.06–40.52)	58.86 (53.63–64.09)	48.19 (43.14–53.24)	3.03 (−1.48 to 7.54)	14.84 (10.39–19.29)	0.047
Asian/PI													
Ratio	0.73 (0.71–0.75)	0.72 (0.70–0.75)	0.65 (0.63–0.67)	0.49 (0.46–0.51)	0.57 (0.55–0.59)	0.64 (0.61–0.66)	0.57 (0.55–0.59)	0.56 (0.53–0.58)	0.61 (0.59–0.63)	0.49 (0.46–0.51)	0.55 (0.53–0.57)	0.57 (0.55–0.59)	0.040
Excess	−136.39 (−144.95 to −127.83)	−142.47 (−150.68 to −134.26)	−178.65 (−186.13 to −171.17)	−268.88 (−275.19 to −262.57)	−213.33 (−219.89 to −206.77)	−161.84 (−168.09 to −155.59)	−193.68 (−199.47 to −187.89)	−196.91 (−202.41 to −191.41)	−155.95 (−161.40 to −150.50)	−204.26 (−208.93 to −199.59)	−169.42 (−174.10 to −164.74)	−162.26 (−166.88 to −157.64)	0.528
Women†													
Black													
Ratio	2.46 (2.46–2.47)	2.40 (2.40–2.41)	2.52 (2.52–2.53)	1.98 (1.97–1.98)	2.52 (2.51–2.53)	2.64 (2.64–2.65)	2.36 (2.35–2.36)	2.41 (2.41–2.42)	2.77 (2.76–2.77)	2.59 (2.58–2.59)	2.45 (2.45–2.46)	2.40 (2.40–2.41)	0.725
Excess	593.02 (587.01–599.03)	574.91 (568.98–580.84)	595.38 (589.53–601.23)	376.89 (371.77–382.01)	539.86 (534.41–545.31)	529.97 (524.72–535.22)	440.05 (435.11–444.99)	439.02 (434.18–443.86)	494.92 (490.04–499.80)	454.93 (450.20–459.66)	393.16 (388.74–397.58)	373.84 (369.56–378.12)	0.015
Hispanic													
Ratio	1.55 (1.54–1.56)	1.81 (1.80–1.82)	1.51 (1.50–1.52)	2.13 (2.12–2.14)	1.60 (1.59–1.60)	1.39 (1.38–1.40)	1.16 (1.15–1.17)	1.25 (1.24–1.26)	1.28 (1.27–1.29)	1.23 (1.22–1.24)	1.09 (1.08–1.10)	1.08 (1.07–1.09)	0.004
Excess	223.74 (217.58–229.90)	332.72 (326.19–339.25)	200.71 (195.04–206.38)	438.38 (430.12–446.64)	211.29 (206.05–216.53)	124.81 (120.29–129.33)	51.73 (47.65–55.81)	76.85 (72.81–80.89)	77.73 (72.81–80.89)	66.96 (63.16–70.76)	24.43 (21.06–27.80)	22.15 (18.89–25.41)	0.003
Asian/PI													
Ratio	0.76 (0.74–0.78)	0.75 (0.73–0.77)	0.74 (0.72–0.76)	0.52 (0.50–0.54)	0.68 (0.66–0.70)	0.73 (0.71–0.75)	0.67 (0.64–0.69)	0.63 (0.61–0.65)	0.69 (0.67–0.71)	0.52 (0.49–0.54)	0.58 (0.56–0.60)	0.57 (0.55–0.59)	0.021
Excess	−96.39 (−102.94 to −89.84)	−101.64 (−107.97 to −95.31)	−103.22 (−109.11 to −97.33)	−185.83 (−190.58 to −181.08)	−113.00 (−118.05 to −107.95)	−87.76 (−92.55 to −82.97)	−108.62 (−113.10 to −104.14)	−113.85 (−118.02 to −109.68)	−87.02 (−91.16 to −82.88)	−138.21 (−141.75 to −134.67)	−113.38 (−116.87 to −109.89)	−114.14 (−117.46 to −110.82)	0.199

Values are presented as ratios or excess number of admissions per 100 000. 95% CIs in parentheses. Ratio: ratio of age-standardized hospitalization rate over reference. Excess: difference in age-standardized hospitalization between subgroup and reference. CI indicates confidence interval; and PI, Pacific Islander.

*Reference group is female.

†Reference group is white.

for patient factors.[18] Given the chronic HF care needs, evaluating the number of days at home and the quality of life after a HF discharge necessitates increased research attention.[19]

Although our results indicate a decreasing HF burden on average, the improvements are not equally distributed across subpopulations based on sex and race/ethnicity. Relative differences by sex and race/ethnicity have either improved, stagnated, or worsened. For men, between 2002 and 2013, the relative difference in the HF hospitalization burden has increased relative to women. This pattern has not been as perceptible because women are a larger proportion of the general HF population given their longer life expectancies.[20]

With respect to race/ethnicity, the difference in the burden of HF is striking. Black men and women have a nearly two and half-fold higher age-standardized hospitalization rates when compared with whites and the disparity has not narrowed relative to whites during the last decade. The relative difference between blacks and whites is underappreciated when looking at crude rates that do not account for the younger age distribution of minority groups. The higher HF hospitalization burden among blacks reflects the much higher morbidity and mortality from cardiovascular disease in the population and the loss of preventable life years. Additionally, hospitalizations impart a greater financial cost to the healthcare system, particularly in comparison to preventative strategies aimed at reducing the incidence of HF and acute decompensations of preexisting HF. In contrast, Hispanics had a 44.9% greater HF hospitalization rate in 2002 when compared with whites. The relative difference between Hispanics and whites narrowed considerably to 6.2% in 2013. For Asians/PI, the age-standardized HF hospitalization rate continued to improve relative to whites and is now nearly half their rate.

There has been limited exploration of the differential HF burden by race/ethnicity. Community surveillance from the Atherosclerosis Risk in Communities study between 2005 and 2009 noted the highest HF hospitalization, and readmission rates were among black men, followed by black women, white men, and the lowest among white women.[21] Work on the differences in the incidence of HF between racial/ethnic groups was reported in the MESA (Multi-ethnic Study of Atherosclerosis). After a median follow-up of 4 years between 2000 and 2002, blacks had the highest crude incidence rate of 460 followed by Hispanics at 350, whites at 240, and Chinese Americans at 100 per 100 000.[22] Although this was a high-quality cohort study with objective echocardiographic evaluation, the number of events (n=79 with new HF) were relatively small to make precise subgroup estimates. The measured difference in incidence rate in the MESA is similar in magnitude to the measured difference in the age-standardized hospitalization rates between racial/ethnic groups in the 2002 NIS. Therefore, age-standardized hospitalization rate ratios may be a useful surrogate for the relative incidence rate of HF between subgroups.

Race/ethnic associations with cardiovascular disease, incident HF, and HF hospitalizations may be strongly confounded by social and socioeconomic status in the United States. There is a strong suggestion that discrimination and chronic stress contribute to adverse cardiovascular health among marginalized minority groups, but additional research is required to isolate causal factors.[23,24] The higher hospitalization burden among blacks and Hispanics is more reflective of underlying determinants of health rather than genetic or physiological differences.[25] A study from the Women's Health Initiative found that the excess risk of incident HF among black women was primarily attributable to diabetes mellitus and lower household incomes.[26] Furthermore, the study was unable to attribute the lower risk among Hispanics and Asian/PI women to measured risk factors. Compared with patient or household level socioeconomic status measurements, neighborhood deprivation indices have been reported as stronger risk factors for rehospitalization risk.[27] Thus, a threshold for poverty and poor neighborhood conditions may be more predictive of adverse health outcomes.

Despite higher HF hospitalization rates compared with whites, Hispanics have narrowed the observed utilization difference during the last decade. Hispanics have a larger representation of foreign-born residents who may contribute to a selection bias related to the healthy migrant effect.[28] Foreign-born populations are associated with a healthier cardiovascular risk profile.[29] Acculturation of immigrant communities is found to parallel progressively poorer cardiovascular health in the United States.[29] Recent population trends indicate a lower rate of foreign-born Hispanic immigrants and higher number of native born.[30] Whether the decreasing Hispanic HF hospitalization rates are sustainable given the increasing prevalence of cardiovascular risk factors among Hispanics should be monitored.[31] Strategies that reduce tobacco use and improve hypertension, diabetes mellitus, and hyperlipidemia control are expected to effectively reduce the HF burden within all subpopulations. Additionally, optimizing HF management with guideline-directed medical therapies for those with prevalent disease is expected to reduce the national HF hospitalization burden further.

Limitations

Some limitations of the data deserve mention. Each NIS sampling unit is derived from a hospitalization and lacks unique patient identifiers; consequently, readmissions are not identified. The risk-adjusted readmissions rate for Medicare patient with HF is ≈23% within 30 days of admission.[2] Of those readmissions, only 17% to 35% are for recurrent HF exacerbations.[32] Therefore, studies using the NIS are not able to distinguish a unique HF hospitalization from a HF readmission. The number of states that participated in the NIS in 2002 was 35 covering 87% of the US population, and it increased to 44 states covering 97% of the US population by 2013.[33] Trend weights accounting for changes in the NIS sampling design are only available for data between 1998 and 2011.[33] For 2012 and 2013, trend weights were not available, and the standard survey weights were used. The NIS found that modifications in their hospital sampling strategy in 2012 may have decreased total hospitalization by 0.7% secondary to the exclusion of long-term acute-care hospitals.[33] The degree to which these modifications affect the HF hospitalization counts for 2012 and 2013 is unknown. Ethnicity data for Hispanic/non-Hispanic is not ascertained as a separate variable in the NIS. As mentioned previously, racial/ethnic classification data are differentially missing between early and more recent years of the NIS. For the 2002 NIS, 27.51% of the sample lacked racial/

ethnic classification, whereas only 4.63% were missing for the 2013 NIS. To overcome this limitation, a multinomial logistic model using patient and hospital characteristics was used to impute race/ethnicity per NIS recommendations.[13] Imputations may be insufficient to accurately correct crude and age-standardized HF hospitalization rates by race. The 2005 NIS reported a lower minority representation compared to all other years of the NIS. This 20% hospital sample likely lacked a representative population based on race/ethnicity, or alternatively, discharges with missing race/ethnic classification (27.5%) were disproportionately distributed among minority patients. This unusual pattern of race/ethnic representation in the 2005 NIS was not observed for the other 11 years of the NIS.

The *International Classification of Diseases*, Ninth Revision codes are not well validated for distinguishing between HF with reduced ejection fraction and HF with preserved ejection fraction patients without echocardiographic or chart-abstracted data. Sex and racial/ethnic differences in the relative burden of HF with reduced ejection fraction and HF with preserved ejection fraction are well described. Women and whites have a higher risk for HF with preserved ejection fraction compared with men and other race/ethnic groups.[34] HF with preserved ejection fraction patients also have a higher observed hospital readmission rate compared with HF with reduced ejection fraction patients.[35]

Conclusions

The NIS is the largest representative data set for all-payer hospitalizations in the United States. The NIS uses a robust weighted sample, 7 million of an estimated 35 million total hospitalizations per year. Current estimates for the national HF burden rely on cross-sectional survey data using self-report or cohort studies without nationally representative sampling strategies.[2,36] Despite its limitations, the NIS data set provides a unique opportunity to understand the epidemiology of HF hospital utilization. These data may also serve as an important surrogate marker for a population's cardiovascular health and the progress of healthcare interventions. This study, to the best of our knowledge, is the first to report on the racial/ethnic differences in the national HF hospitalization rates between whites, blacks, Hispanics, and Asians/PI. This is also the first study to appropriately age-standardize hospitalization rates using the 2000 US standard million and single-year of life adjustments. Single-year of life adjustments effectively removes residual bias related to differential age distributions within 10-year or greater age intervals. Incomplete age standardization using larger strata would be expected to diminish the measured differences in rates when comparing subpopulations with younger age distributions between eras or racial/ethnic groups. The HF hospitalization rate reflects the prevalence of cardiovascular risk factors and incident HF within a given population.

Between 2002 and 2013, the age-standardized HF hospitalization and mortality rates have improved nationally. This confirms that despite an aging population, hospital utilization rates for HF have decreased. Unfortunately, differences in the HF hospitalization burden between men and women have not changed significantly during the reported period. Among minorities, blacks have a HF hospitalization rate that is nearly two and half-fold higher than whites. The relative difference in the rate of HF hospitalization between blacks and whites has not narrowed during the 12 years of observation. In contrast, the difference in HF hospitalization burden narrowed for Hispanics when compared with whites during the same period of observation. Asians/PIs have consistently maintained the lowest rates of HF hospitalization when compared with all other racial/ethnic groups. The variation between subgroups in the HF hospitalization rates suggests a large portion of the burden is preventable through population health interventions. Age-standardized HF hospitalization rates are a useful metric of a population's cardiovascular health and should be followed for targeting interventions and narrowing health disparities between groups over time.

Sources of Funding

Dr Ziaeian was supported by the National Institutes of Health (NIH) Cardiovascular Scientist Training Program (T32 HL007895). Dr Mays was partially supported by NIH and National Institute on Minority Health and Health Disparities (0006932).

Disclosures

Dr Fonarow receives research funding from the National Institutes of Health and consulting fees from Amgen, Janssen, Medtronic, Novartis, and St Jude Medical. The other authors report no conflicts.

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SUPPLEMENTAL MATERIAL

Supplemental Table I: ICD-9-CM codes used to define heart failure.

Code	Description
398.91	Rheumatic heart failure (congestive)
402.01	Malignant hypertensive heart disease with heart failure
402.11	Benign hypertensive heart disease with heart failure
402.91	Unspecified hypertensive heart disease with heart failure
404.01	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage i through stage iv, or unspecified
404.03	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage v or end stage renal disease
404.11	Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage i through stage iv, or unspecified
404.13	Hypertensive heart and chronic kidney disease, benign, with heart failure and chronic kidney disease stage v or end stage renal disease
404.91	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage i through stage iv, or unspecified
404.93	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and chronic kidney disease stage v or end stage renal disease
428.0	Congestive heart failure unspecified
428.1	Left heart failure
428.20	Unspecified systolic heart failure
428.21	Acute systolic heart failure
428.22	Chronic systolic heart failure
428.23	Acute on chronic systolic heart failure
428.30	Unspecified diastolic heart failure
428.31	Acute diastolic heart failure
428.32	Chronic diastolic heart failure
428.33	Acute on chronic diastolic heart failure
428.40	Unspecified combined systolic and diastolic heart failure
428.41	Acute combined systolic and diastolic heart failure
428.42	Chronic combined systolic and diastolic heart failure
428.43	Acute on chronic combined systolic and diastolic heart failure
428.9	Heart failure unspecified

Supplemental Table II: HF patient characteristics and comorbidities nationally by sex for 2002, 2007, 2013 from the National Inpatient Sample.

	2002		2007		2013	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Age	70.49	74.90	69.86	74.97	69.98	74.64
Race/Ethnicity						
White	70.51%	70.31%	65.82%	67.25%	67.22%	67.93%
Black	17.65%	18.31%	20.41%	19.79%	19.93%	20.13%
Hispanic	7.18%	7.08%	8.07%	7.59%	7.91%	7.33%
Asian/PI	1.68%	1.52%	1.78%	1.83%	2.01%	1.93%
Census Region						
New England	4.72%	4.81%	6.36%	6.77%	4.85%	5.11%
Mid Atlantic	16.26%	16.34%	13.27%	12.92%	14.95%	15.12%
East North Central	15.99%	16.77%	18.15%	18.79%	16.31%	17.20%
West North Central	7.10%	7.34%	5.78%	6.33%	6.13%	6.23%
South Atlantic	26.73%	25.95%	25.40%	24.75%	22.07%	21.77%
East South Central	5.41%	6.40%	4.37%	4.59%	7.29%	8.12%
West South Central	8.03%	7.83%	10.28%	10.58%	11.32%	11.26%
Mountain	2.12%	1.95%	4.04%	3.29%	4.58%	3.79%
Pacific	13.65%	12.62%	12.36%	11.98%	12.50%	11.40%
Hospital Size						
Small	12.20%	13.02%	12.71%	14.37%	14.48%	15.85%
Medium	25.29%	26.44%	26.28%	27.38%	26.73%	27.31%
Large	62.51%	60.54%	61.01%	58.25%	58.79%	56.84%
Hospital Location						
Rural	17.60%	19.81%	14.52%	16.78%	13.22%	15.19%
Urban, nonteaching	45.48%	45.81%	44.54%	45.37%	38.88%	39.68%
Urban, teaching	36.92%	34.38%	40.94%	37.85%	47.90%	45.14%
Primary Payer						
Medicare	72.66%	79.41%	69.88%	78.14%	70.27%	79.63%
Medicaid	6.18%	6.88%	7.54%	7.38%	8.64%	7.49%
Private insurance	15.77%	10.90%	15.20%	10.50%	13.12%	8.96%
Self-pay	3.11%	1.62%	4.28%	2.33%	4.59%	2.32%
No charge	0.27%	0.16%	0.52%	0.30%	0.51%	0.24%
Other	1.93%	1.00%	2.41%	1.23%	2.70%	1.24%
Comorbidities†						
HTN	57.08%	60.42%	64.73%	66.04%	70.96%	70.55%
CAD	30.55%	24.20%	32.00%	26.62%	34.92%	28.39%
Atrial fibrillation	14.55%	10.92%	17.02%	12.33%	19.54%	14.91%
Obese	17.35%	20.39%	19.65%	20.90%	30.97%	34.50%
Valve disease	15.60%	18.36%	18.70%	21.71%	21.57%	23.76%
VT	6.24%	3.67%	7.56%	4.31%	8.49%	5.09%
AMI	1.72%	1.62%	1.96%	1.72%	2.36%	2.00%
PVD	4.25%	4.14%	5.05%	4.84%	6.77%	6.51%
DM	30.85%	36.26%	32.79%	38.55%	37.67%	40.88%
COPD	18.26%	16.37%	18.13%	17.30%	17.62%	17.97%
Anemia	15.40%	24.16%	18.56%	28.57%	25.91%	36.56%
Fluid/electrolyte	18.86%	19.20%	23.25%	24.99%	31.69%	31.97%

PI = Pacific Islander, HTN = hypertension, CAD = coronary artery disease, VT = ventricular tachycardia, AMI = acute myocardial infarction, PVD = peripheral vascular disease, DM = diabetes mellitus, COPD = chronic obstructive pulmonary disease.

† Age-standardized proportions to 2000 U.S. standard population.

Supplemental Table III: HF patient characteristics and comorbidities nationally by race/ethnicity for 2002, 2007, 2013 from the National Inpatient Sample.

	2002				2007				2013			
	White	**Black**	**Hispanic**	**Asian**	**White**	**Black**	**Hispanic**	**Asian**	**White**	**Black**	**Hispanic**	**Asian**
Age	75.67	63.96	69.28	72.57	76.06	62.93	67.62	71.90	75.39	63.36	68.96	71.53
Female	54.67%	55.65%	54.37%	52.28%	51.88%	50.56%	49.78%	51.97%	49.28%	49.41%	47.17%	47.98%
Census Region												
New England	5.85%	1.88%	2.90%	1.82%	8.49%	2.48%	3.40%	2.14%	6.21%	2.00%	3.50%	2.43%
Mid Atlantic	18.63%	11.04%	8.40%	5.91%	12.98%	13.12%	12.94%	10.59%	15.05%	14.62%	13.39%	10.84%
East North Central	17.12%	16.46%	11.15%	11.86%	18.57%	21.90%	10.34%	10.79%	17.92%	18.01%	5.74%	8.51%
West North Central	7.92%	7.51%	1.55%	1.84%	7.36%	4.26%	1.55%	2.35%	7.42%	4.28%	1.93%	2.32%
South Atlantic	24.50%	36.82%	21.53%	8.60%	23.68%	33.07%	19.91%	12.26%	19.47%	34.30%	17.56%	7.19%
East South Central	5.70%	8.77%	2.56%	1.47%	4.84%	3.87%	2.01%	1.31%	9.50%	5.82%	0.78%	0.66%
West South Central	6.32%	7.25%	23.42%	5.44%	9.49%	11.31%	17.82%	3.72%	9.76%	12.28%	21.67%	5.26%
Mountain	2.23%	1.12%	1.75%	1.83%	3.83%	2.04%	5.24%	2.65%	4.48%	1.81%	7.01%	4.02%
Pacific	11.74%	9.14%	26.73%	61.21%	10.76%	7.95%	26.79%	54.19%	10.18%	6.90%	28.41%	58.74%
Hospital Size												
Small	13.92%	8.56%	9.23%	21.12%	14.98%	10.85%	8.55%	14.30%	16.47%	11.97%	11.88%	14.28%
Medium	25.00%	27.87%	31.51%	25.39%	26.63%	26.78%	27.22%	36.18%	26.75%	27.39%	29.79%	24.91%
Large	61.09%	63.57%	59.25%	53.49%	58.39%	62.37%	64.23%	49.53%	56.78%	60.64%	58.33%	60.80%
Hospital Location												
Rural	21.33%	12.26%	11.71%	11.69%	18.36%	10.50%	7.33%	3.69%	17.40%	7.47%	5.59%	5.84%
Urban, nonteaching	47.97%	35.99%	49.08%	49.17%	48.54%	34.49%	44.82%	44.77%	41.23%	30.41%	44.87%	47.42%
Urban, teaching	30.70%	51.76%	39.21%	39.14%	33.11%	55.01%	47.85%	51.54%	41.38%	62.12%	49.54%	46.73%
Primary Payer												
Medicare	81.85%	60.86%	66.99%	64.88%	81.41%	57.35%	59.88%	66.59%	81.30%	59.70%	63.61%	65.27%
Medicaid	3.50%	14.70%	13.13%	13.68%	3.29%	15.41%	19.18%	14.93%	4.05%	17.06%	16.15%	15.12%
Private Insurance	12.15%	16.56%	12.96%	16.84%	11.87%	16.18%	11.74%	13.95%	13.79%	9.98%	12.72%	11.63%
Self-Pay	1.24%	5.14%	4.61%	3.02%	1.74%	7.31%	5.62%	3.02%	2.25%	6.19%	6.73%	4.42%
No Charge	0.10%	0.54%	0.35%	0.10%	0.20%	0.84%	1.01%	0.15%	0.21%	0.78%	0.70%	0.29%
Other	1.12%	2.14%	1.93%	1.50%	1.44%	2.71%	2.54%	1.31%	1.76%	2.36%	2.73%	2.14%
Comorbidities †												
HTN	44.72%	72.02%	57.60%	58.87%	53.73%	74.46%	68.13%	65.84%	63.51%	79.13%	69.70%	67.57%
CAD	29.79%	22.88%	28.54%	29.92%	32.43%	25.76%	29.34%	29.33%	34.73%	28.83%	31.55%	32.40%
Atrial Fibrillation	15.96%	8.72%	11.54%	19.52%	18.58%	10.85%	13.01%	20.78%	20.80%	13.80%	14.78%	18.80%
Obese	17.20%	20.43%	15.75%	12.72%	19.98%	22.02%	16.18%	14.89%	31.78%	33.65%	29.96%	23.59%
Valve Disease	19.43%	13.63%	16.78%	19.82%	20.48%	19.00%	17.38%	20.69%	23.99%	20.27%	20.98%	23.56%
VT	5.63%	5.20%	4.72%	2.94%	6.66%	6.33%	4.87%	3.90%	8.05%	6.79%	4.96%	5.72%
AMI	1.81%	1.26%	2.12%	3.12%	2.43%	1.42%	1.68%	3.15%	2.66%	1.55%	2.90%	2.86%
PVD	4.58%	3.58%	4.23%	2.78%	5.30%	4.23%	4.93%	4.00%	7.52%	5.56%	6.64%	6.17%
DM	31.91%	33.93%	38.82%	34.10%	33.20%	34.94%	42.36%	40.50%	37.08%	39.16%	45.00%	46.80%
COPD	20.48%	14.62%	12.29%	11.64%	21.14%	15.52%	12.21%	9.25%	21.07%	15.49%	11.67%	10.44%
Anemia	15.36%	22.42%	19.09%	19.70%	19.38%	24.11%	25.85%	20.22%	26.05%	33.64%	31.78%	31.31%
Fluid/Electrolyte	18.52%	19.94%	16.79%	19.60%	25.12%	23.29%	25.25%	26.28%	31.54%	31.69%	32.87%	29.23%

PI = Pacific Islander, HTN = hypertension, CAD = coronary artery disease, VT = ventricular tachycardia, AMI = acute myocardial infarction, PVD = peripheral vascular disease, DM = diabetes mellitus, COPD = chronic obstructive pulmonary disease.

† Age-standardized proportions to 2000 U.S. standard population.

Supplemental Table IV: National trends in disposition after a primary heart failure admission from the National Inpatient Sample.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
National (unadjusted)												
LOS (mean)	5.59	5.54	5.49	5.38	5.30	5.26	5.29	5.26	5.20	5.13	5.22	5.28
Died	4.26%	4.07%	3.95%	3.78%	3.50%	3.24%	3.29%	3.21%	3.05%	3.05%	3.09%	3.01%
Home/Home health	74.13%	74.56%	73.11%	73.08%	73.69%	73.11%	73.23%	73.22%	72.85%	72.13%	72.77%	72.83%
SNF/ICF	16.85%	16.69%	18.09%	18.63%	18.43%	19.29%	19.34%	19.35%	19.97%	20.60%	20.11%	20.04%
Short-term hospital	3.65%	3.51%	3.81%	3.45%	3.25%	3.17%	2.98%	3.06%	2.94%	3.02%	2.94%	2.94%
Other	1.11%	1.16%	1.03%	1.06%	1.13%	1.19%	1.16%	1.17%	1.19%	1.19%	1.10%	1.19%
National (age-standardized)												
Died	2.46%	2.36%	2.22%	1.90%	2.00%	2.04%	1.97%	2.09%	1.82%	1.85%	1.96%	1.77%
Home/Home health	84.45%	85.19%	83.94%	84.22%	84.45%	84.15%	85.13%	83.78%	84.90%	84.33%	84.77%	84.80%
SNF/ICF	5.71%	5.78%	6.31%	6.28%	6.33%	6.56%	6.27%	6.59%	6.53%	6.88%	6.78%	6.93%
Short-term hospital	4.54%	4.01%	4.79%	4.61%	4.17%	4.03%	3.86%	4.29%	3.54%	3.90%	3.83%	3.50%
Other	2.84%	2.67%	2.74%	3.00%	3.04%	3.22%	2.77%	3.25%	3.21%	3.04%	2.67%	3.00%

Supplemental Table V: National trends in disposition after a primary heart failure admission by sex from the NIS.

Male (unadjusted)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
LOS (mean)	5.51	5.44	5.36	5.25	5.19	5.17	5.21	5.24	5.16	5.10	5.24	5.28
Died	4.46%	4.11%	3.99%	3.77%	3.40%	3.13%	3.28%	3.19%	3.01%	3.06%	3.12%	3.07%
Home/Home health	77.10%	78.01%	76.55%	76.86%	77.31%	76.88%	76.95%	76.68%	76.52%	75.59%	76.10%	75.84%
SNF/ICF	12.86%	12.50%	13.73%	13.93%	14.01%	14.75%	14.86%	15.08%	15.49%	16.26%	15.98%	16.06%
Short-term hospital	4.08%	3.90%	4.26%	3.89%	3.63%	3.57%	3.29%	3.39%	3.29%	3.41%	3.23%	3.33%
Other	1.51%	1.48%	1.47%	1.56%	1.65%	1.68%	1.62%	1.66%	1.69%	1.67%	1.57%	1.69%
Male (age-standardized)												
Died	2.79%	2.36%	2.39%	2.14%	2.19%	2.21%	2.01%	2.18%	2.01%	1.67%	2.15%	2.01%
Home/Home health	83.55%	85.19%	83.68%	83.71%	84.02%	84.30%	82.88%	84.03%	84.87%	84.91%	84.66%	84.71%
SNF/ICF	5.43%	5.11%	5.67%	5.65%	5.83%	6.16%	5.54%	6.13%	5.62%	5.96%	6.16%	6.48%
Short-term hospital	4.97%	4.20%	4.97%	4.95%	4.48%	3.85%	4.25%	4.13%	3.79%	3.98%	4.03%	3.61%
Other	3.26%	3.15%	3.30%	3.56%	3.48%	3.48%	5.33%	3.53%	3.71%	18.25%	3.00%	3.19%
Female (unadjusted)												
LOS (mean)	5.67	5.62	5.60	5.49	5.40	5.35	5.36	5.27	5.24	5.16	5.20	5.28
Died	4.09%	4.04%	3.92%	3.80%	3.59%	3.34%	3.31%	3.21%	3.09%	3.05%	3.05%	2.94%
Home/Home health	71.68%	71.63%	70.06%	69.60%	70.30%	69.54%	69.66%	69.82%	69.16%	68.74%	69.43%	69.69%
SNF/ICF	20.15%	20.23%	21.97%	22.95%	22.59%	23.59%	23.62%	23.54%	24.47%	24.87%	24.26%	24.17%
Short-term hospital	3.29%	3.19%	3.42%	3.05%	2.88%	2.80%	2.69%	2.74%	2.60%	2.63%	2.64%	2.53%
Other	0.78%	0.90%	0.63%	0.59%	0.65%	0.72%	0.72%	0.69%	0.68%	0.71%	0.62%	0.67%
Female (age-standardized)												
Died	2.05%	2.31%	2.12%	1.74%	1.75%	1.71%	2.04%	2.05%	1.61%	2.24%	1.67%	1.46%
Home/Home health	85.70%	85.46%	84.59%	85.07%	85.50%	84.51%	85.51%	83.60%	84.75%	83.85%	85.25%	84.96%
SNF/ICF	6.00%	6.48%	6.82%	6.74%	6.78%	6.94%	7.14%	7.09%	7.90%	7.85%	7.55%	7.66%
Short-term hospital	4.02%	3.63%	4.54%	4.40%	3.58%	4.11%	3.34%	4.54%	3.31%	3.86%	3.41%	3.27%
Other	2.24%	2.12%	1.93%	2.05%	2.40%	2.73%	1.98%	2.72%	2.42%	2.20%	2.12%	2.65%

LOS = length of stay, Home/Home health = discharged home or with home health care services, SNF/ICF = discharged to skilled nursing facility, intermediate care facility, or another type of facility, Transfer short-term, Other = includes missing, against medical advice, discharged to court/law enforcement

Supplemental Table VI: National trends in disposition after a primary heart failure admission by race/ethnicity from the NIS.

White (unadjusted)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
LOS (mean)	5.58	5.60	5.46	5.41	5.25	5.21	5.25	5.20	5.17	5.09	5.16	5.23
Died	4.84%	4.61%	4.44%	4.31%	3.97%	3.73%	3.73%	3.72%	3.58%	3.57%	3.58%	3.44%
Home/Home health	71.14%	71.55%	70.19%	70.11%	70.58%	69.60%	70.15%	69.93%	68.95%	68.33%	69.15%	69.21%
SNF/ICF	19.34%	19.24%	20.67%	21.22%	21.32%	22.49%	22.13%	22.34%	23.54%	24.00%	23.34%	23.30%
Short-term hospital	3.84%	3.71%	3.95%	3.55%	3.39%	3.34%	3.16%	3.25%	3.13%	3.21%	3.12%	3.18%
Other	0.84%	0.90%	0.75%	0.81%	0.73%	0.83%	0.82%	0.75%	0.80%	0.89%	0.80%	0.87%
White (age-standardized)												
Died	3.03%	2.32%	2.85%	2.42%	2.37%	2.00%	2.62%	2.66%	2.22%	2.66%	2.22%	1.89%
Home/Home health	81.16%	84.19%	81.83%	82.79%	84.64%	83.05%	84.09%	82.88%	83.08%	81.49%	83.11%	82.97%
SNF/ICF	6.06%	6.53%	6.90%	7.06%	6.33%	6.73%	6.53%	7.05%	6.90%	7.88%	7.38%	7.65%
Short-term hospital	7.05%	5.06%	6.22%	5.45%	4.48%	5.67%	4.62%	4.88%	5.22%	5.76%	4.83%	4.63%
Other	2.70%	1.90%	2.21%	2.29%	2.18%	2.54%	2.14%	2.53%	2.58%	2.21%	2.47%	2.87%
Black (unadjusted)												
LOS (mean)	5.59	5.67	5.47	5.29	5.40	5.31	5.30	5.30	5.23	5.19	5.33	5.40
Died	2.55%	2.41%	2.36%	2.07%	2.05%	1.97%	1.89%	1.75%	1.72%	1.72%	1.76%	1.69%
Home/Home health	82.41%	82.48%	80.80%	81.26%	81.33%	81.03%	81.57%	81.30%	81.24%	80.45%	80.97%	81.25%
SNF/ICF	10.57%	10.67%	11.94%	3.09%	11.87%	12.28%	12.26%	12.27%	12.64%	2.90%	13.03%	12.86%
Short-term hospital	2.78%	2.67%	3.12%	2.95%	2.63%	2.65%	2.23%	2.42%	2.39%	2.48%	2.42%	2.21%
Other	1.69%	1.76%	1.78%	10.62%	2.12%	2.07%	2.04%	2.27%	2.02%	12.45%	1.81%	2.00%
Black (age-standardized)												
Died	1.87%	2.12%	1.78%	1.50%	1.55%	1.71%	1.37%	1.78%	1.41%	1.42%	1.41%	1.28%
Home/Home health	87.30%	86.78%	85.31%	85.40%	85.07%	84.92%	86.55%	85.24%	86.26%	85.84%	86.53%	86.84%
SNF/ICF	5.34%	5.35%	5.83%	6.08%	6.61%	6.54%	6.21%	6.31%	6.16%	6.41%	6.43%	6.23%
Short-term hospital	2.62%	2.92%	3.94%	3.55%	3.41%	3.35%	2.62%	3.12%	2.35%	2.89%	2.94%	2.36%
Other	2.87%	2.83%	3.14%	3.46%	3.36%	3.48%	3.25%	3.55%	3.81%	3.43%	2.69%	3.28%

Continued Supplemental Table VI

Hispanic (unadjusted)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
LOS (mean)	5.52	5.93	5.63	5.33	5.38	5.43	5.64	5.49	5.33	5.23	5.22	5.26
Died	3.17%	3.34%	3.28%	2.64%	2.88%	2.27%	2.62%	2.30%	2.17%	2.32%	2.31%	2.56%
Home/Home health	81.10%	81.46%	79.60%	78.36%	80.63%	80.89%	79.55%	80.00%	80.65%	80.12%	80.58%	80.32%
SNF/ICF	10.38%	10.14%	11.56%	11.12%	11.69%	12.40%	13.00%	13.13%	12.66%	13.21%	12.77%	13.03%
Short-term hospital	3.81%	3.23%	3.99%	3.09%	3.00%	2.75%	2.74%	2.63%	2.45%	2.90%	2.68%	2.45%
Other	1.53%	1.82%	1.57%	4.78%	1.80%	1.68%	2.09%	1.94%	2.07%	1.45%	1.66%	1.64%
Hispanic (age-standardized)												
Died	3.75%	2.63%	1.78%	1.98%	2.46%	2.00%	2.11%	1.72%	1.09%	1.21%	1.70%	3.10%
Home/Home health	84.74%	83.15%	85.94%	82.28%	84.58%	87.30%	85.58%	84.86%	87.28%	86.62%	88.17%	85.83%
SNF/ICF	4.16%	4.78%	4.88%	4.63%	4.46%	5.02%	5.21%	5.84%	5.14%	4.61%	4.76%	5.53%
Short-term hospital	4.38%	4.05%	4.29%	4.98%	4.14%	2.62%	4.29%	3.54%	3.70%	4.28%	2.59%	2.76%
Other	2.96%	5.39%	3.10%	6.13%	4.37%	3.06%	2.81%	4.04%	2.79%	3.29%	2.78%	2.78%
Asian/PI (unadjusted)												
LOS (mean)	5.79	6.21	5.90	5.55	6.11	5.62	5.42	5.52	5.26	5.20	5.47	5.17
Died	3.96%	3.53%	4.10%	3.42%	3.31%	3.37%	3.46%	2.73%	2.96%	3.06%	2.52%	3.31%
Home/Home health	81.42%	79.89%	77.00%	78.28%	78.68%	77.87%	77.38%	79.40%	77.83%	58.05%	79.51%	78.29%
SNF/ICF	13.54%	4.14%	13.53%	13.74%	13.94%	14.34%	15.21%	14.09%	15.25%	14.73%	14.17%	13.65%
Short-term hospital	3.25%	11.08%	4.13%	3.85%	3.07%	2.93%	2.88%	2.59%	2.81%	2.78%	2.58%	3.49%
Other	-2.16%	1.36%	1.24%	0.72%	1.01%	1.48%	1.07%	1.18%	1.15%	21.38%	1.22%	1.27%
Asian/PI (age-standardized)												
Died	2.37%	1.68%	2.09%	1.27%	1.10%	3.37%	1.78%	1.93%	5.77%	2.05%	1.43%	2.27%
Home/Home health	83.58%	88.54%	86.16%	85.51%	87.85%	84.05%	87.13%	85.28%	82.67%	88.28%	87.46%	86.72%
SNF/ICF	4.73%	4.14%	5.31%	5.55%	4.38%	5.19%	5.43%	4.92%	5.64%	4.79%	4.52%	4.37%
Short-term hospital	4.77%	4.31%	5.27%	5.95%	3.64%	2.82%	4.09%	5.83%	3.55%	2.65%	3.60%	4.03%
Other	4.54%	1.34%	1.17%	1.72%	3.04%	4.57%	1.58%	2.04%	2.38%	2.24%	3.00%	2.61%

LOS = length of stay, Home/Home health = discharged home or with home health care services, SNF/ICF = discharged to skilled nursing facility, intermediate care facility, or another type of facility, Transfer short-term, Other = includes missing, against medical advice, discharged to court/law enforcement

Supplemental Table VII: Race/Ethnic classification of HF hospitalizations for 2002 and 2013 pre- and post-imputation from the National Inpatient Sample.

	2002		2013	
	Pre-imputation	**Post-imputation**	**Pre-imputation**	**Post-imputation**
White	70.69%	70.93%	67.46%	67.69%
Black	18.06%	18.14%	20.16%	20.06%
Hispanic	7.44%	7.18%	7.72%	7.64%
Asian/PI	1.66%	1.61%	2.00%	1.97%

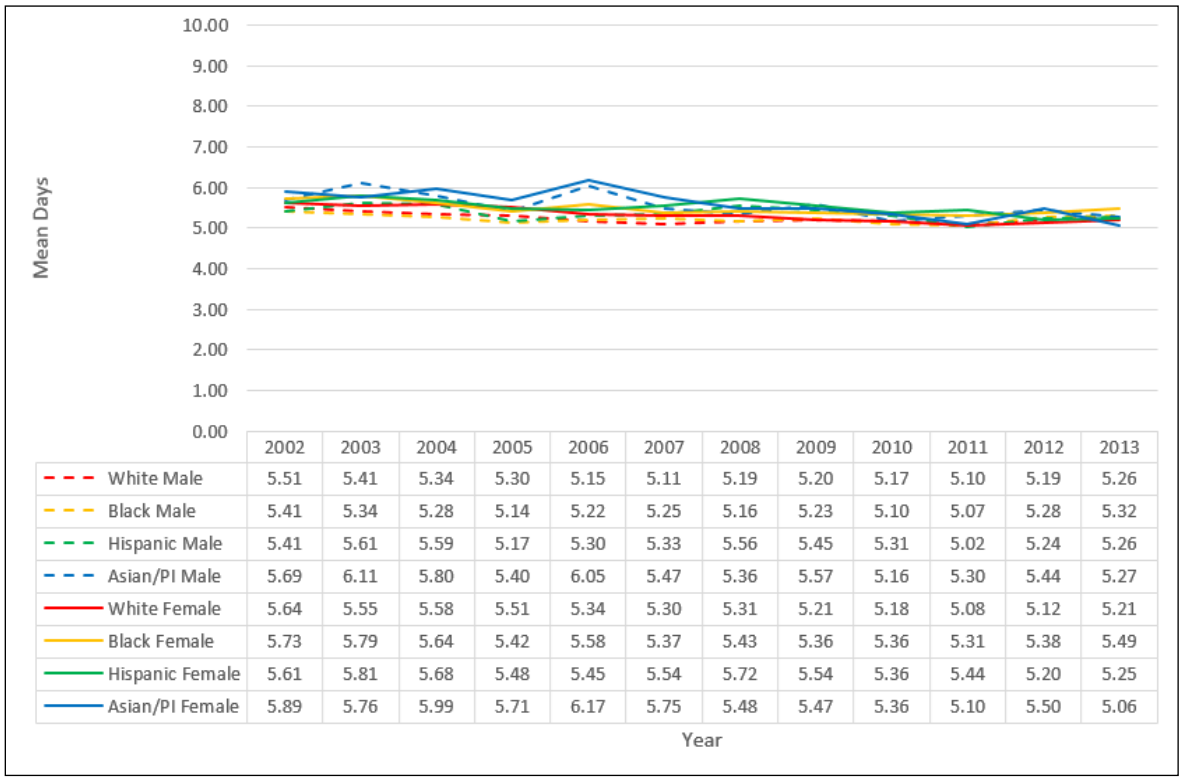
Supplemental Table VIII: Measures of difference in the crude HF hospitalization rate by sex and race/ethnicity from the National Inpatient Sample.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	p-trend
Male													
Ratio	0.88	0.90	0.94	0.97	0.99	1.00	1.01	1.03	1.06	1.04	1.06	1.10	0.001
Excess	-66.35	-56.05	-32.45	-14.52	-3.91	-0.18	3.81	14.44	26.22	16.52	24.22	36.30	0.002
Male ‡													
Black													
Ratio	1.57	1.59	1.73	1.39	1.77	1.94	1.71	1.77	2.11	1.96	1.91	1.91	0.015
Excess	289.71	304.92	374.92	204.96	380.99	419.34	322.85	339.18	442.03	380.06	340.61	342.96	0.203
Hispanic													
Ratio	0.55	0.69	0.59	0.62	0.62	0.61	0.50	0.55	0.57	0.56	0.52	0.56	0.073
Excess	-226.50	-161.50	-212.17	-197.26	-187.46	-174.49	-224.51	-201.60	-171.36	-175.18	-178.92	-167.56	0.139
Asian/PI													
Ratio	0.40	0.43	0.39	0.31	0.36	0.42	0.40	0.40	0.42	0.35	0.40	0.42	0.703
Excess	-304.78	-293.79	-311.00	-359.61	-316.95	-256.51	-273.26	-267.40	-232.81	-259.83	-225.73	-218.80	0.008
Female‡													
Black													
Ratio	2.11	2.07	2.19	1.73	2.23	2.37	2.12	2.19	2.54	2.40	2.31	2.30	0.054
Excess	450.85	436.45	465.76	283.28	437.06	442.33	363.49	371.37	431.54	399.88	354.83	347.42	0.154
Hispanic													
Ratio	0.89	1.04	0.90	0.86	0.99	0.90	0.75	0.83	0.79	0.76	0.70	0.72	0.007
Excess	-46.21	17.95	-39.94	-52.36	-2.82	-32.18	-79.82	-53.23	-60.19	-67.47	-79.73	-75.40	0.024
Asian/PI													
Ratio	0.50	0.52	0.51	0.38	0.51	0.57	0.54	0.53	0.52	0.41	0.47	0.48	0.619
Excess	-203.13	-197.53	-190.03	-238.50	-173.59	-137.62	-150.77	-147.08	-134.98	-170.17	-142.73	-137.38	0.014

Values are presented as ratios or excess number of admissions per 100,000.

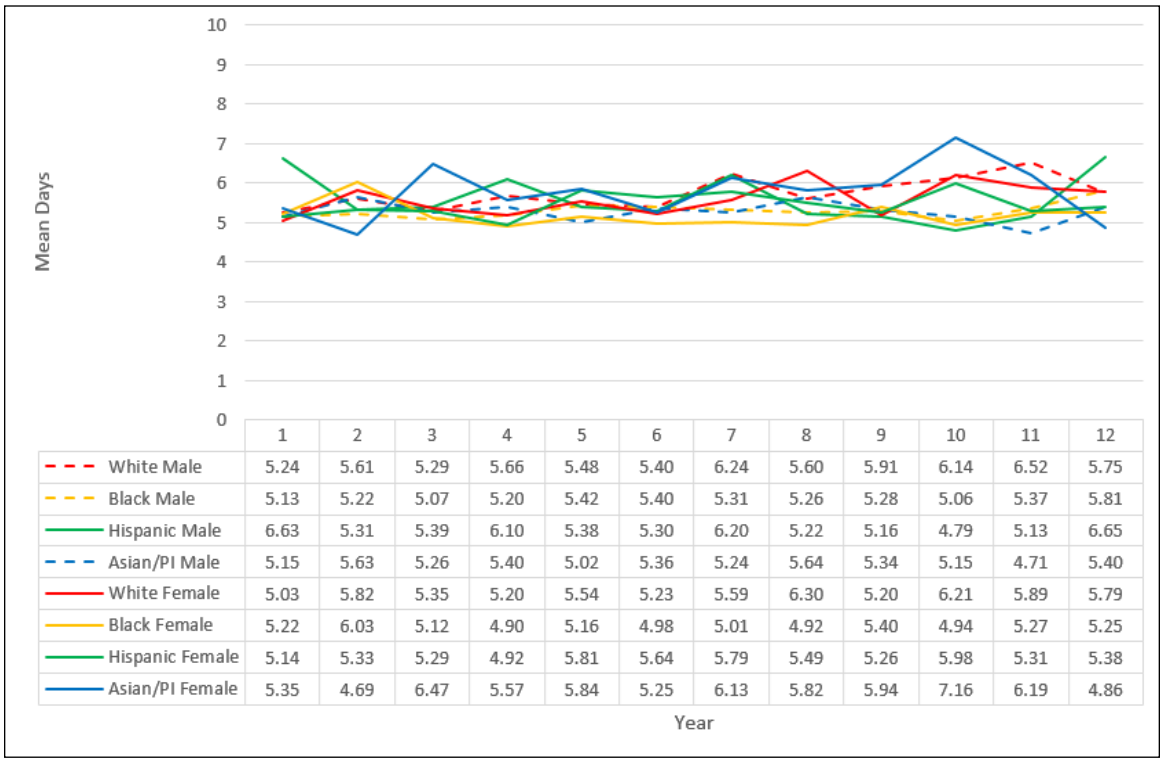
PI = Pacific Islander, Ratio = ratio of crude hospitalization rate over reference, Excess = difference in crude hospitalization between subgroup and reference.
† reference group is female
‡ reference group is white

Supplemental Figure IA: Mean length of stay (unadjusted) by sex and race/ethnicity from the National Inpatient Sample.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
White Male	5.51	5.41	5.34	5.30	5.15	5.11	5.19	5.20	5.17	5.10	5.19	5.26
Black Male	5.41	5.34	5.28	5.14	5.22	5.25	5.16	5.23	5.10	5.07	5.28	5.32
Hispanic Male	5.41	5.61	5.59	5.17	5.30	5.33	5.56	5.45	5.31	5.02	5.24	5.26
Asian/PI Male	5.69	6.11	5.80	5.40	6.05	5.47	5.36	5.57	5.16	5.30	5.44	5.27
White Female	5.64	5.55	5.58	5.51	5.34	5.30	5.31	5.21	5.18	5.08	5.12	5.21
Black Female	5.73	5.79	5.64	5.42	5.58	5.37	5.43	5.36	5.36	5.31	5.38	5.49
Hispanic Female	5.61	5.81	5.68	5.48	5.45	5.54	5.72	5.54	5.36	5.44	5.20	5.25
Asian/PI Female	5.89	5.76	5.99	5.71	6.17	5.75	5.48	5.47	5.36	5.10	5.50	5.06

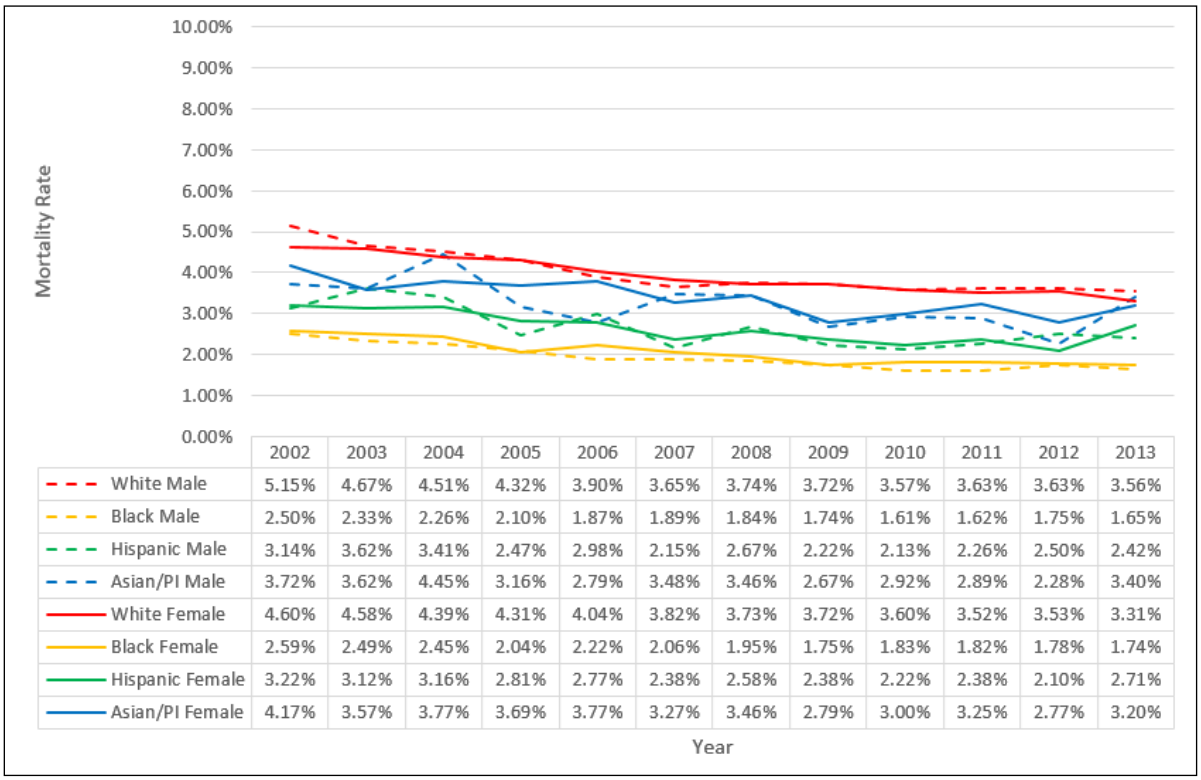
Supplemental Figure IB: Mean length of stay (age-adjusted) by sex and race/ethnicity from the National Inpatient Sample.



	1	2	3	4	5	6	7	8	9	10	11	12
White Male	5.24	5.61	5.29	5.66	5.48	5.40	6.24	5.60	5.91	6.14	6.52	5.75
Black Male	5.13	5.22	5.07	5.20	5.42	5.40	5.31	5.26	5.28	5.06	5.37	5.81
Hispanic Male	6.63	5.31	5.39	6.10	5.38	5.30	6.20	5.22	5.16	4.79	5.13	6.65
Asian/PI Male	5.15	5.63	5.26	5.40	5.02	5.36	5.24	5.64	5.34	5.15	4.71	5.40
White Female	5.03	5.82	5.35	5.20	5.54	5.23	5.59	6.30	5.20	6.21	5.89	5.79
Black Female	5.22	6.03	5.12	4.90	5.16	4.98	5.01	4.92	5.40	4.94	5.27	5.25
Hispanic Female	5.14	5.33	5.29	4.92	5.81	5.64	5.79	5.49	5.26	5.98	5.31	5.38
Asian/PI Female	5.35	4.69	6.47	5.57	5.84	5.25	6.13	5.82	5.94	7.16	6.19	4.86

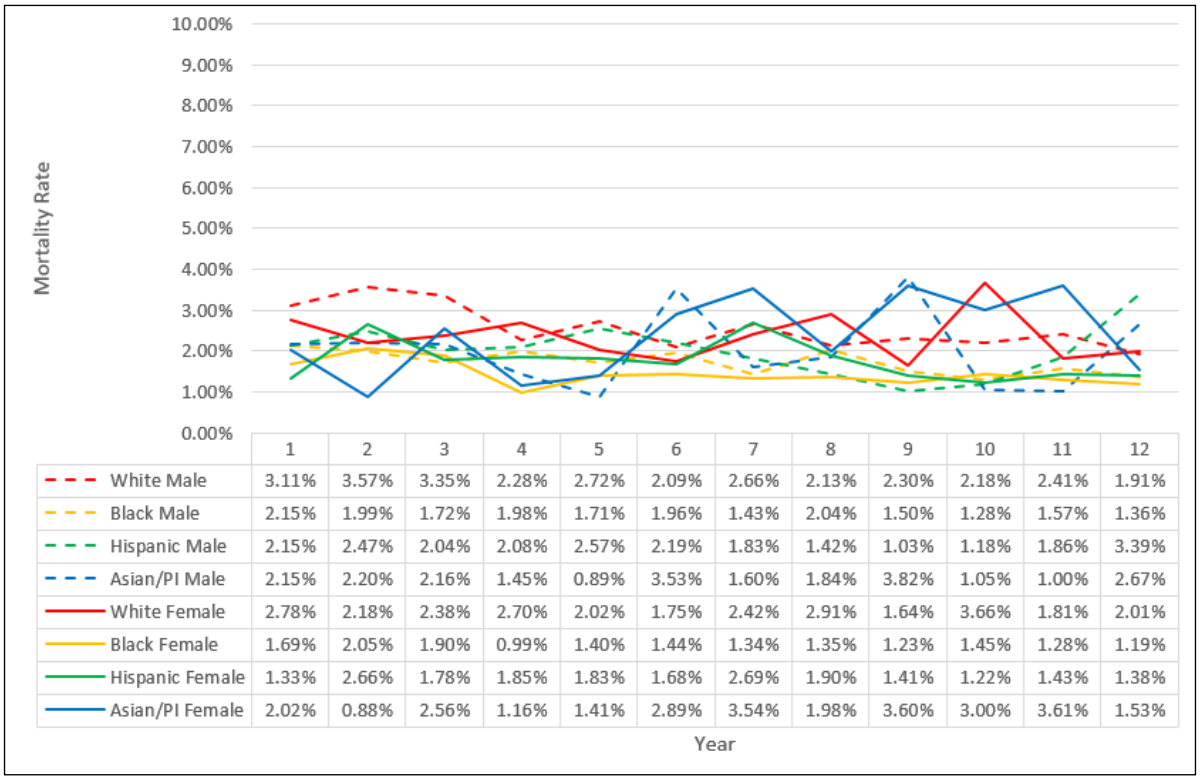
PI = Pacific Islander

Supplemental Figure IIA: Inpatient mortality rate (unadjusted) by sex and race/ethnicity from the National Inpatient Sample.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
White Male	5.15%	4.67%	4.51%	4.32%	3.90%	3.65%	3.74%	3.72%	3.57%	3.63%	3.63%	3.56%
Black Male	2.50%	2.33%	2.26%	2.10%	1.87%	1.89%	1.84%	1.74%	1.61%	1.62%	1.75%	1.65%
Hispanic Male	3.14%	3.62%	3.41%	2.47%	2.98%	2.15%	2.67%	2.22%	2.13%	2.26%	2.50%	2.42%
Asian/PI Male	3.72%	3.62%	4.45%	3.16%	2.79%	3.48%	3.46%	2.67%	2.92%	2.89%	2.28%	3.40%
White Female	4.60%	4.58%	4.39%	4.31%	4.04%	3.82%	3.73%	3.72%	3.60%	3.52%	3.53%	3.31%
Black Female	2.59%	2.49%	2.45%	2.04%	2.22%	2.06%	1.95%	1.75%	1.83%	1.82%	1.78%	1.74%
Hispanic Female	3.22%	3.12%	3.16%	2.81%	2.77%	2.38%	2.58%	2.38%	2.22%	2.38%	2.10%	2.71%
Asian/PI Female	4.17%	3.57%	3.77%	3.69%	3.77%	3.27%	3.46%	2.79%	3.00%	3.25%	2.77%	3.20%

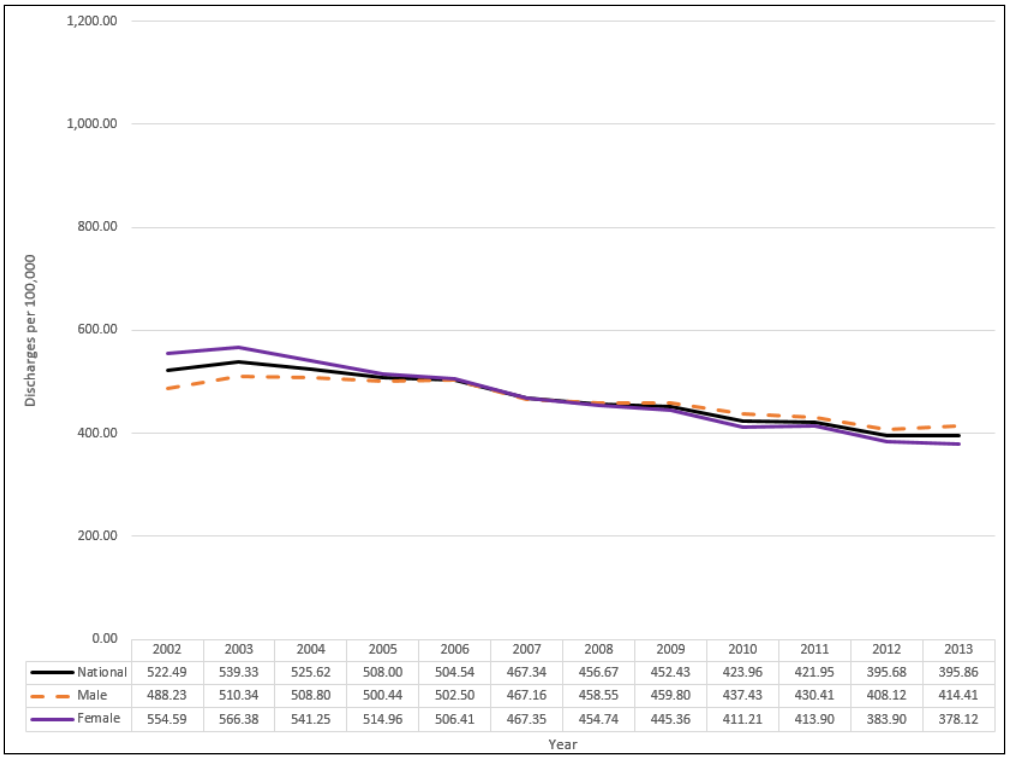
Supplemental Figure IIB: Inpatient mortality rate (age-adjusted) by sex and race/ethnicity from the National Inpatient Sample.



	1	2	3	4	5	6	7	8	9	10	11	12
White Male	3.11%	3.57%	3.35%	2.28%	2.72%	2.09%	2.66%	2.13%	2.30%	2.18%	2.41%	1.91%
Black Male	2.15%	1.99%	1.72%	1.98%	1.71%	1.96%	1.43%	2.04%	1.50%	1.28%	1.57%	1.36%
Hispanic Male	2.15%	2.47%	2.04%	2.08%	2.57%	2.19%	1.83%	1.42%	1.03%	1.18%	1.86%	3.39%
Asian/PI Male	2.15%	2.20%	2.16%	1.45%	0.89%	3.53%	1.60%	1.84%	3.82%	1.05%	1.00%	2.67%
White Female	2.78%	2.18%	2.38%	2.70%	2.02%	1.75%	2.42%	2.91%	1.64%	3.66%	1.81%	2.01%
Black Female	1.69%	2.05%	1.90%	0.99%	1.40%	1.44%	1.34%	1.35%	1.23%	1.45%	1.28%	1.19%
Hispanic Female	1.33%	2.66%	1.78%	1.85%	1.83%	1.68%	2.69%	1.90%	1.41%	1.22%	1.43%	1.38%
Asian/PI Female	2.02%	0.88%	2.56%	1.16%	1.41%	2.89%	3.54%	1.98%	3.60%	3.00%	3.61%	1.53%

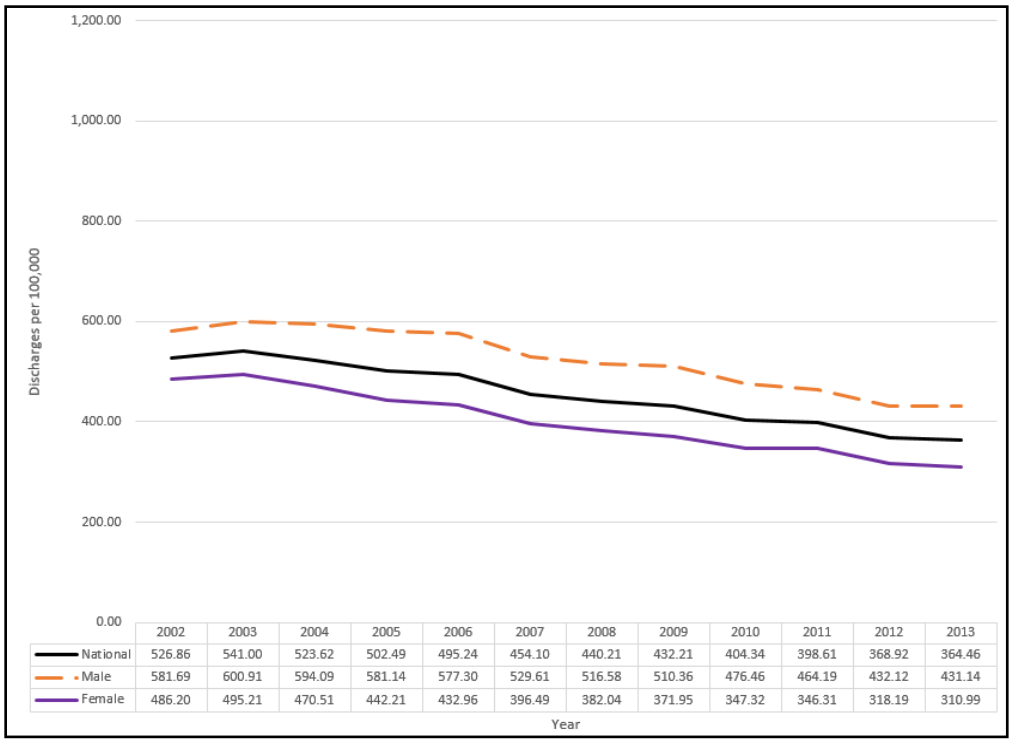
PI = Pacific Islander

Supplemental Figure IIIA: National crude hospitalization rate by sex from the National Inpatient Sample.



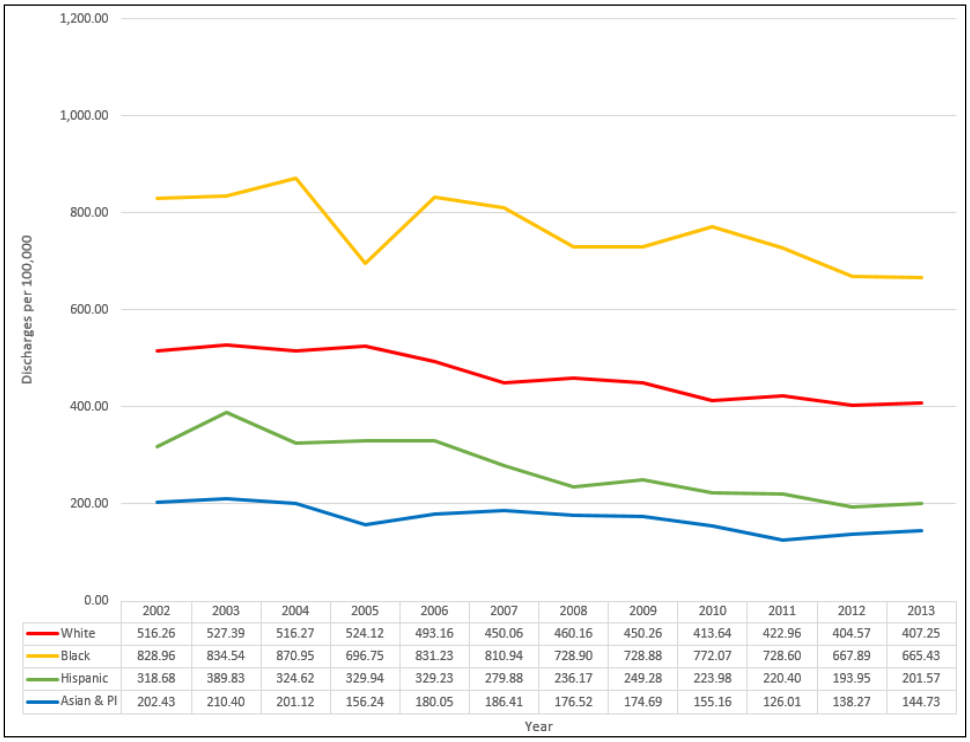
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
National	522.49	539.33	525.62	508.00	504.54	467.34	456.67	452.43	423.96	421.95	395.68	395.86
Male	488.23	510.34	508.80	500.44	502.50	467.16	458.55	459.80	437.43	430.41	408.12	414.41
Female	554.59	566.38	541.25	514.96	506.41	467.35	454.74	445.36	411.21	413.90	383.90	378.12

Supplemental Figure IIIB: National age-standardized hospitalization rate by sex from the National Inpatient Sample.



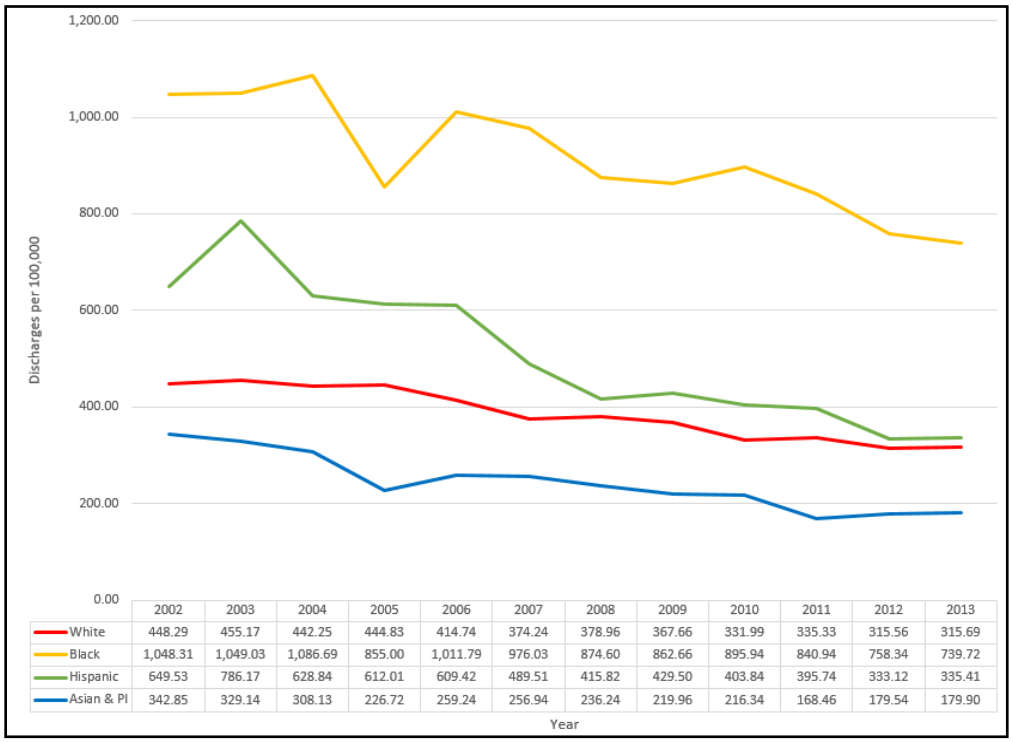
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
National	526.86	541.00	523.62	502.49	495.24	454.10	440.21	432.21	404.34	398.61	368.92	364.46
Male	581.69	600.91	594.09	581.14	577.30	529.61	516.58	510.36	476.46	464.19	432.12	431.14
Female	486.20	495.21	470.51	442.21	432.96	396.49	382.04	371.95	347.32	346.31	318.19	310.99

Supplemental Figure IVA: National crude hospitalization rate by race/ethnicity from the National Inpatient Sample.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
White	516.26	527.39	516.27	524.12	493.16	450.06	460.16	450.26	413.64	422.96	404.57	407.25
Black	828.96	834.54	870.95	696.75	831.23	810.94	728.90	728.88	772.07	728.60	667.89	665.43
Hispanic	318.68	389.83	324.62	329.94	329.23	279.88	236.17	249.28	223.98	220.40	193.95	201.57
Asian & PI	202.43	210.40	201.12	156.24	180.05	186.41	176.52	174.69	155.16	126.01	138.27	144.73

Supplemental Figure IVB: National age-standardized hospitalization rate by race/ethnicity from the National Inpatient Sample.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
White	448.29	455.17	442.25	444.83	414.74	374.24	378.96	367.66	331.99	335.33	315.56	315.69
Black	1,048.31	1,049.03	1,086.69	855.00	1,011.79	976.03	874.60	862.66	895.94	840.94	758.34	739.72
Hispanic	649.53	786.17	628.84	612.01	609.42	489.51	415.82	429.50	403.84	395.74	333.12	335.41
Asian & PI	342.85	329.14	308.13	226.72	259.24	256.94	236.24	219.96	216.34	168.46	179.54	179.90

PI = Pacific Islander