

Supplementary Online Content

Pandey A, Patel KV, Liang L, et al. Association of hospital performance based on 30-day risk-standardized mortality rate with long-term survival after heart failure hospitalization: an analysis of the Get With The Guidelines–Heart Failure Registry. *JAMA Cardiol*. Published online March 12, 2018. doi:10.1001/jamacardio.2018.0579

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eReferences.

This supplementary material has been provided by the authors to give readers additional information about their work.

eMethods 1. Get With The Guidelines (GWTG)–Heart Failure (HF) cohort description

The AHA started the GWTG-HF hospital-based quality improvement program in 2005 to improve adherence to guideline recommendations in the care of hospitalized patients with HF. Details of the GWTG-HF registry design and objectives have been published previously.^{1,2} Briefly, the registry includes rural and urban, teaching and nonteaching, small and large hospitals from all regions of the United States. All participating centers are required to comply with local regulatory and institutional review board guidelines. Patients admitted with new or worsening heart failure or patients who develop significant heart failure symptoms during their hospitalization are included in the registry. Trained personnel at each participating center abstract and report patient data in compliance with the Joint Commission and CMS standards using the AHA's web-based Patient Management Tool (Quintiles Real World & Late Phase Research, Cambridge, Massachusetts). Data collected included patient demographics, socioeconomic status, medical history, initial vital signs and labs, baseline medications, left ventricular ejection fraction, and hospital characteristics (heart transplant center, cardiac surgery onsite, etc.).

eMethods 2. Covariates used in the model to determine the 30-day risk-standardized mortality rates for each participating center

Demographics: age, gender, race (AA, Hispanic vs. White);

SES: median household income, % with 4+years college, % with high school;

Medical history: atrial fib/flutter, COPD, DM, dyslipidemia, hypertension, PVD, stroke, ICD, anemia, pace maker, dialysis, renal insufficiency, depression, valvular disease, CRT-P, CRT-D, ischemic heart disease (combined CAD, MI, prior PCI, prior CABG, prior PCI/CABG), smoker

EF: HFrEF vs. HFpEF;

Vital signs at admission: weight, heart rate, systolic BP, respiratory rate;

Labs at admission: sodium, BNP, Scr, BUN, GFR, hemoglobin, Troponin;

Admission medications: ACEi/ARB combined, beta blocker, aldosterone antagonist, digoxin, diuretic, warfarin;

Number of all-cause hospitalizations within 6 months prior to index hospitalization:

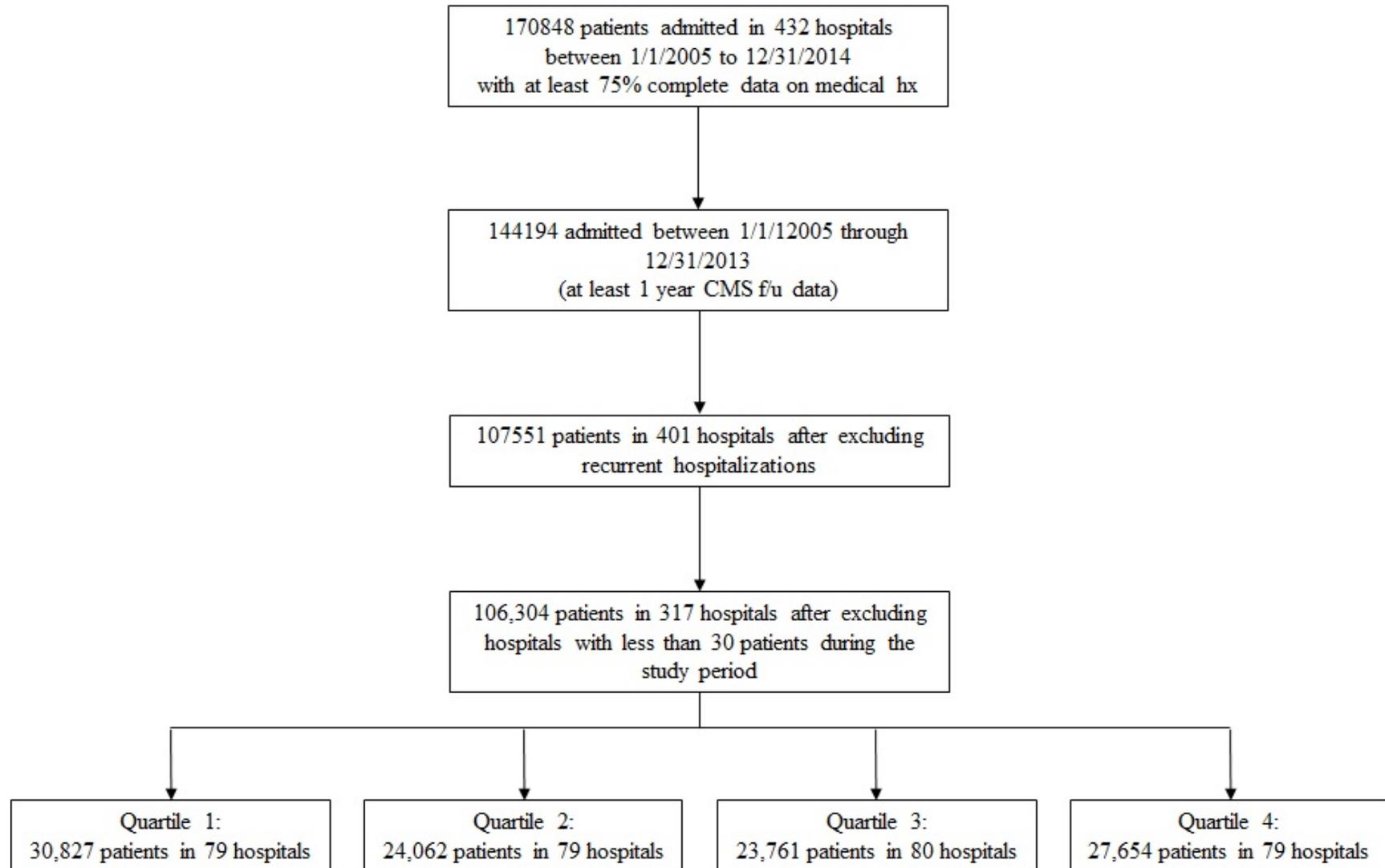
Hierarchical Condition Category (HCC) codes for the index admission used to define protein-calorie malnutrition (code 21), dementia (codes 49-50), disability (ie, paraplegia, 68; spinal cord disorders/injuries, 69; hemiplegia/hemiparesis, 100; paralysis, 101; speech, language, cognitive, and perceptual deficits, 102; and amputation and complications, 177 and 178), major psychiatric disorders (codes 54, 55, and 56), and chronic liver disease (codes 25, 26, and 27);

eMethods 3. Hospital characteristics used in the model to determine the association between 30-day risk-standardized mortality rate–based hospital groups and long-term mortality

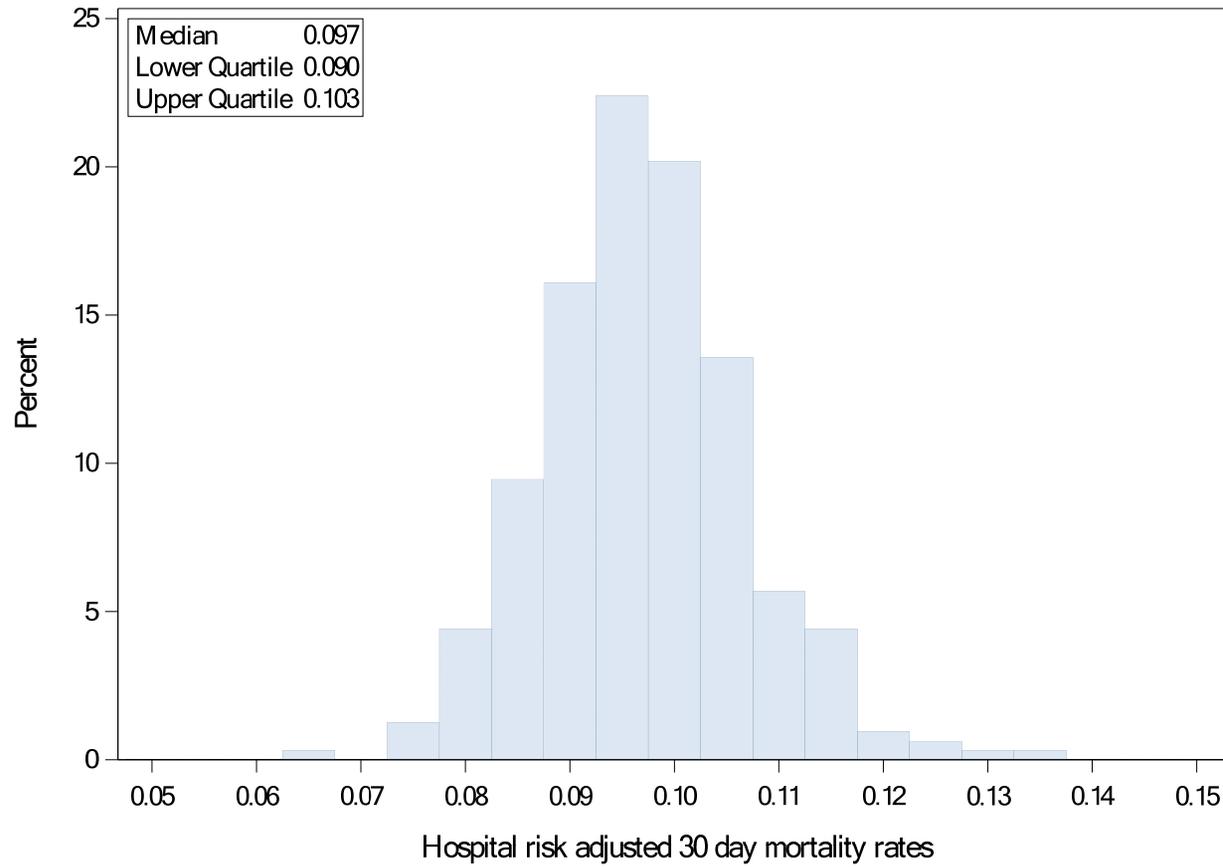
In addition to the patient covariates, hospital characteristics region, number of beds, teaching hospital and rural vs. urban are included in the model.

Adjustment included the following continuous variables: age, SES variables, vital signs and labs, and hospital number of beds. The relationship of each continuous variable with the 30-day mortality was evaluated first. Data showed that the relationship is linear for the 3 SES variables, respiratory rate, serum creatinine, and hospital number of beds, and thus a single linear variable for each of them was used in the model; non-linearity exists for other continuous variables, and thus piecewise linear splines were determined based upon the relationship and used in the adjustment model. Missingness in co-variates was low for demographics and medical history (0% for sex, 2% for race, 7% for medical history, <1% for SES) and handled using multiple imputations.

eFigure 1. CONSORT study flow diagram



eFigure 2. Histogram of hospital 30-day risk-standardized mortality rate



eTable 1. Multivariable-adjusted association between 30-day risk-standardized mortality rate (RSMR)–based hospital groups and long-term outcomes according to heart failure (HF) subtypes (HFpEF vs HFrEF) in the overall population

Outcomes	Hospital Group Comparison	HFpEF Adjusted HR (95% CI)	HFrEF Adjusted HR (95% CI)	P-value for interaction
1-Year Mortality	High vs. Low 30-day RSMR [Q4 vs. Q1 (ref)]	1.30 (1.24 - 1.36)	1.34 (1.26 - 1.41)	0.3818
3-Year Mortality	High vs. Low 30-day RSMR [Q4 vs. Q1 (ref)]	1.20 (1.15 - 1.25)	1.29 (1.23 - 1.35)	0.0039
5-Year Mortality	High vs. Low 30-day RSMR [Q4 vs. Q1 (ref)]	1.20 (1.15 - 1.24)	1.28 (1.22 - 1.34)	0.0049
<p>*Adjusted for patient and hospital characteristics. This analysis includes the overall study population counting the deaths within the first 30-days HFpEF: Heart failure with preserved ejection fraction; HFrEF: Heart failure with reduced ejection fraction</p>				

eTable 2. Long-term mortality risk among hospitalized patients with heart failure according to 30-day risk-standardized mortality rate (RSMR)—early period (2005-2009; 206 hospitals and 43 410 patients)

	Hospital Group	30-day survivors Adj. HR (95 % CI)	All patients Adj. HR (95 % CI)
1-Year Mortality	Q1 (Low 30-day RSMR)	Ref.	Ref.
	Q2	1.05 (1.00 - 1.10)	1.07(1.02 - 1.13)
	Q3	1.09 (1.03 - 1.15)	1.14 (1.08 - 1.21)
	Q4 (High 30-day RSMR)	1.08 (1.02 - 1.15)	1.18 (1.11 - 1.24)
3-Year Mortality	Q1 (Low 30-day RSMR)	Ref.	Ref.
	Q2	1.03 (0.98 - 1.08)	1.05 (1.00 - 1.09)
	Q3	1.08 (1.04 - 1.13)	1.11 (1.07 - 1.16)
	Q4 (High 30-day RSMR)	1.07 (1.02 - 1.13)	1.13 (1.08 - 1.19)
5-Year Mortality	Q1 (Low 30-day RSMR)	Ref.	Ref.
	Q2	1.03 (0.98 - 1.07)	1.04 (1.00 - 1.09)
	Q3	1.08 (1.04 - 1.12)	1.11 (1.06 - 1.15)
	Q4 (High 30-day RSMR)	1.08 (1.03 - 1.13)	1.13 (1.08 - 1.18)
Separate Cox models are constructed for each outcome with adjustment for patient and hospital variables as detailed in Supplemental methods.			

eTable 3. Long-term mortality risk among hospitalized patients with heart failure according to 30-day risk-standardized mortality rate (RSMR)—late period (2010-2013; 249 hospitals and 62 894 patients)

	Hospital Group	30-day survivors Adj. HR (95 % CI)	All patients Adj. HR (95 % CI)
1-Year Mortality	Q1 (Low 30-day RSMR)	Ref.	Ref.
	Q2	1.06 (1.00 - 1.12)	1.09 (1.04 - 1.14)
	Q3	1.07 (1.01 - 1.12)	1.11 (1.06 - 1.17)
	Q4 (High 30-day RSMR)	1.14 (1.08 - 1.19)	1.23 (1.18 - 1.28)
3-Year Mortality	Q1 (Low 30-day RSMR)	Ref.	Ref.
	Q2	1.04 (1.00 - 1.09)	1.06 (1.02 - 1.11)
	Q3	1.06 (1.01 - 1.11)	1.09 (1.05 - 1.14)
	Q4 (High 30-day RSMR)	1.12 (1.08 - 1.16)	1.18 (1.14 - 1.23)
5-Year Mortality	Q1 (Low 30-day RSMR)	Ref.	Ref.
	Q2	1.04 (0.99 - 1.09)	1.06 (1.01 - 1.11)
	Q3	1.06 (1.01 - 1.11)	1.09 (1.04 - 1.13)
	Q4 (High 30-day RSMR)	1.12 (1.08 - 1.16)	1.18 (1.13 - 1.22)
Separate Cox models are constructed for each outcome with adjustment for patient and hospital variables as detailed in Supplemental methods.			

eTable 4. Long-term mortality risk among hospitalized patients with heart failure according to 30-day risk-standardized mortality rate (RSMR)—addition of calendar year in the adjustment

		30-day survivors	All patients
	Hospital Group	Adj. HR (95 % CI)	Adj. HR (95 % CI)
1-Year Mortality	Q1 (Low 30-day RSMR)	Ref.	Ref.
	Q2	1.06 (1.01 – 1.11)	1.11 (1.07 – 1.15)
	Q3	1.06 (1.01 – 1.11)	1.15 (1.11 – 1.19)
	Q4 (High 30-day RSMR)	1.17 (1.12 – 1.22)	1.30 (1.25 – 1.35)
3-Year Mortality	Q1 (Low 30-day RSMR)	Ref.	Ref.
	Q2	1.05 (1.01 – 1.09)	1.08 (1.04 – 1.12)
	Q3	1.05 (1.01 – 1.09)	1.10 (1.07 – 1.14)
	Q4 (High 30-day RSMR)	1.14 (1.10 – 1.18)	1.22 (1.18 – 1.26)
5-Year Mortality	Q1 (Low 30-day RSMR)	Ref.	Ref.
	Q2	1.04 (1.00 – 1.09)	1.07 (1.03 – 1.11)
	Q3	1.04 (1.01 – 1.08)	1.09 (1.06 – 1.13)
	Q4 (High 30-day RSMR)	1.13 (1.10 – 1.7)	1.21 (1.17 – 1.25)
Separate Cox models are constructed for each outcome with adjustment for patient and hospital variables as detailed in Supplemental methods and calendar time.			

eTable 5. Long-term mortality risk among hospitalized patients with heart failure according to 30-day risk-standardized mortality rate (RSMR)—only continuous participating hospitals (hospitals with at least 1 patient entered in 2005-2007 period and at least 1 patient each calendar year thereafter; 56 hospitals and 41 898 patients)

Risk of Long term outcomes	30-day survivors Adj. HR (95 % CI)	Overall Population Adj. HR (95% CI)
1-year mortality High 30-day RSMR (Q4) vs. low 30-day RSMR (Q1, ref.)	1.17 (1.08 -1.27)	1.29 (1.19 - 1.39)
3-year mortality High 30-day RSMR (Q4) vs. low 30-day RSMR (Q1, ref.)	1.14 (1.07 -1.21)	1.21 (1.13 - 1.29)
5-year mortality High 30-day RSMR (Q4) vs. low 30-day RSMR (Q1, ref.)	1.15 (1.08 – 1.22)	1.21 (1.14 - 1.29)

The hazard ratios presented here are for low (Q1, ref) vs. high (Q4) RSMR comparisons.

eReferences.

1. Hong Y, LaBresh KA. Overview of the American Heart Association “Get With The Guidelines” programs: coronary heart disease, stroke, and heart failure. *Crit Pathw Cardiol.* 2006;5(4):179-186.
2. Smaha LA; American Heart Association. The American Heart Association Get With The Guidelines program. *Am Heart J.* 2004;148(5, suppl):S46-S48.