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12-1-2020

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In-hospital outcomes after bariatric surgery in patients with heart failure



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Based on the largest publicly available all-payer inpatient database in the United States, this study sought to evaluate real-world outcomes after bariatric surgery among patients with heart failure. (*Am Heart J* 2020;230:59-62.)

An estimated 6.2 million adults in the United States (US) have heart failure (HF), with an expected increase to more than 8 million by 2030.¹ The obesity epidemic has been a major contributor to this rising prevalence, and obesity remains one of the strongest risk factors for development of HF.² In contemporary trials recruiting inpatients with HF, a fifth of patients meet body mass index (BMI) criteria for severe obesity (BMI ≥ 40 kg/m²).³ Bariatric surgery, including Roux-en-Y gastric bypass, sleeve gastrectomy, and adjustable gastric banding, are cornerstone therapies for the management of severe obesity. Surgical weight loss in the broad population with obesity yields durable weight reduction, remission of cardiovascular risk factors, and reduced longer-term cardiovascular event rates and mortality.⁴ Contemporary safety data suggest a 30-day postoperative mortality rate after bariatric surgery of <1%.⁵ However, for patients with established HF, the balance of risks and benefits from a surgical weight loss strategy is unknown. Given this evidence gap, this study sought to evaluate real-world outcomes after bariatric surgery among patients with systolic and diastolic HF based upon the largest publicly available all-payer inpatient database in the US.

The study cohort was derived from the 2010-2015 Nationwide Inpatient Sample (NIS) database. The NIS is compiled by the Healthcare Cost and Utilization Project and sponsored by the Agency for Healthcare Research

and Quality; it includes a cross-sectional, stratified sample of approximately 20% of all discharges in the US. *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*, procedure codes were used to identify hospitalizations of adult patients ≤ 18 years who underwent bariatric surgery (44.39, 44.38, and 44.31 for gastric bypass; 43.89 and 43.82 for sleeve gastrectomy; and 44.68 and 44.95 for gastric banding) from January 1, 2010, to September 30, 2015. Starting October 1, 2015, the NIS transitioned to *ICD-10-CM*; hence, our selected time frame represents the last 5 years of NIS using *ICD-9-CM* coding. Patients with certain gastrointestinal malignancies were excluded (150.XX, 151.XX, 152.XX, 157.XX, 199.XX). This approach and the *ICD-9* codes used for bariatric surgery were based on those suggested by the American Society for Metabolic and Bariatric Surgery and methodologies used in previous large-scale publications analyzing postbariatric surgery outcomes.^{6,7} We subsequently identified patients with diagnosis of systolic HF (428.2X) or diastolic HF (428.3X). Patients with systolic and diastolic HF (428.4X) were included in the systolic HF group.

The primary outcome was in-hospital mortality. Secondary outcomes included mean length of hospital stay and postoperative complications. χ^2 and *t* tests were used to compare baseline characteristics, and multivariable logistic regression models were used to compare in-hospital complications and mortality between groups (non-HF vs systolic HF and non-HF vs diastolic HF). Covariates for multivariable models included all baseline characteristics that showed statistically significant differences between cohorts. A subgroup analysis for the primary outcome was performed in patients identified as undergoing surgery via laparoscopic approach (*ICD-9*: 44.38, 43.82, 44.68, 44.95). Two-tailed *P* < .05 was considered statistically significant. Statistical analyses were performed using Stata 14.2 (StataCorp, College Station, TX).

The cohort included an estimated total of 793,411 patients undergoing bariatric surgery. Of these, 788,195

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Gregg C. Fonarow, MD, served as guest editor for this article.

Submitted August 11, 2020; accepted September 14, 2020.

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0002-8703

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<https://doi.org/10.1016/j.ahj.2020.09.007>

Table I. Baseline characteristics of study population undergoing bariatric surgery

	Non-HF	Systolic HF		Diastolic HF	Total
No. of patients (weighted)	788,195 (99.3%)	1915 (0.2%)		3301 (0.4%)	793,411
Bariatric procedure					
Roux-en-Y gastric bypass	46.5%	50.1%		55.4%	
Sleeve gastrectomy	46.7%	46.8%		41.7%	
Adjustable gastric banding	7.4%	3.9%		4.8%	
Laparoscopic approach	87.3%	60.0%		66.6%	
Patient characteristics					
Age (mean ± SE)	45.61 ± 0.03	59.9 ± 0.77	<i>P</i> *	61.37 ± 0.51	<i>P</i> †
Sex			<.001		<.001
Male	22.5%	55.0%		39.8%	
Female	77.5%	45.0%		60.2%	
Race			<.001		<.001
White	67.3%	62.3%		71.1%	
Black	15.8%	24.4%		20.0%	
Hispanic	12.1%	7.7%		3.4%	
Other	4.8%	5.7%		5.5%	
Body mass index (kg/m ²)			<.001		<.001
<35	3.1%	7.1%		4.4%	
35-39.9	19.7%	12.4%		11.6%	
40-44.9	31.8%	23.5%		20.3%	
45-49.9	20.6%	19.9%		22.6%	
50-59.9	19.1%	26.1%		27.9%	
≥60	5.7%	11.1%		13.2%	
Comorbidities					
Hypertension	55.4%	76.23%	<.001	80.3%	<.001
Diabetes mellitus	30.4%	46.3%	<.001	54.9%	<.001
Chronic obstructive pulmonary disease	18.9%	39.0%	<.001	43.5%	<.001
Renal disease	2.2%	21.9%	<.001	23.6%	<.001
Atrial fibrillation	1.9%	28.7%	<.001	24.3%	<.001
Mean Charlson Comorbidity Index (mean ± SE)	0.8 ± 0.003	3.24 ± 0.088	<.001	2.56 ± 0.07	<.001
Hospital characteristics					
Bed size			<.001		<.001
Small	18.9%	11.9%		11.8%	
Medium	29.3%	24.0%		27.7%	
Large	51.8%	64.1%		60.5%	
Teaching status (urban)			.01		<.001
Nonteaching	35.0%	29.0%		28.1%	
Teaching	65.0%	71.0%		71.9%	

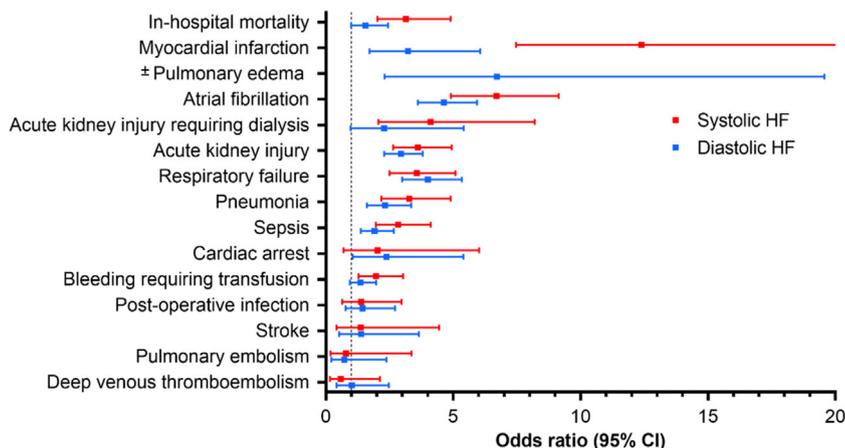
* *P* values reflect comparison between systolic HF and individuals with non-HF.† *P* values reflect comparison between diastolic HF and individuals with non-HF.

(99.3%) patients had non-HF, 1,915 (0.2%) had preexisting systolic HF, and 3,301 (0.4%) had diastolic HF. Gastric bypass and sleeve gastrectomy were the most common bariatric procedures, accounting for >90% of the surgical procedures in each group. Laparoscopic surgery was the most common approach across all cohorts (non-HF: 87.3%, systolic HF: 60.0%, diastolic HF: 66.6%); HF patients were more likely to undergo conventional open surgery when compared to non-HF. Baseline characteristics are described in Table I.

In-hospital mortality among non-HF patients undergoing bariatric surgery was 0.4%. Compared to non-HF patients, systolic HF was independently associated with higher in-hospital mortality (10.3%, adjusted odds ratio [aOR] 3.14; 95% CI 2.02-4.9; *P* < .001). Diastolic HF patients demonstrated a nonsignificant trend toward

higher in-hospital mortality when compared with non-HF (5.7%, aOR 1.55; 95% CI 0.99-2.43; *P* = .056). Among the subgroup of patients undergoing laparoscopic surgery, in-hospital mortality in the non-HF cohort was lower at 0.04%. Patients with systolic HF undergoing laparoscopic surgery had a signal toward higher in-hospital mortality (1.4%, aOR 4.84; 95% CI 0.99-23.8; *P* = .05), and those with diastolic HF had significantly increased in-hospital mortality compared to non-HF patients (1.8%; aOR 8.98; 95% CI 3.3-24.4; *P* < .001). Patients with baseline systolic HF and diastolic HF had a higher incidence of in-hospital complications than non-HF patients. Excess risk for systolic HF and diastolic HF patients was particularly noted for myocardial infarction (9.0% for systolic HF and 3.0% for diastolic HF vs 0.1% non-HF, *P* < .001), atrial fibrillation (28.7% and 24.3% vs

Figure 1



Adjusted outcomes of HF patients undergoing bariatric surgery (reference = non-HF).**Adjusted for age, sex, race, hospital bed size, hospital teaching status, and Charlson Comorbidity Index.*Statistical model for systolic HF failed due to small sample size.

1.9%, $P < .001$), hospital-acquired pneumonia (12.7% and 10.4% vs 0.82%, $P < .001$), respiratory failure (16.8% and 16.9% vs 1.0%, $P < .001$), sepsis (16.5% and 12.7% vs 1.04%, $P < .001$), and acute kidney injury (27.9% and 25.9% vs 1.9%, $P < .001$) (Figure 1). Some complications were noted to be higher in a specific HF subgroup; when compared to patients without HF, patients with systolic HF were more likely to have acute kidney injury requiring dialysis (3.6% vs 0.1%, $P < .001$) and bleeding requiring transfusion (9.6% vs 1.4%, $P = .002$), whereas patients with diastolic HF were more likely to have pulmonary edema (0.6% vs 0.04%, $P < .001$) and cardiac arrest (1.4% vs 0.1%, $P = .038$). Patients with HF had a longer length of hospital stay (systolic HF mean 13.2 days [$P < .001$] and diastolic HF mean 10.3 days [$P < .001$] vs non-HF mean 2.8 days).

Bariatric surgery is the most effective strategy for achieving significant and sustained weight loss for patients with severe obesity and is associated with reduction in longer-term risk of cardiovascular disease and mortality. The benefit of surgical weight loss strategies in patients with established HF is less clear. According to our analysis, despite a high prevalence of comorbid obesity, only a small proportion of bariatric surgeries in the US are performed in patients with HF. Furthermore, systolic HF or diastolic HF is independently associated with higher risk of in-hospital complications and significantly higher in-hospital mortality. Contemporary studies describe 30-day postoperative mortality rates in the range of 0.04%-0.3% for bariatric procedures.^{5,8} The presently reported 0.4% in-hospital mortality among patients without HF in our overall cohort and 0.04% in the laparoscopic cohort is consistent with these prior observations.

Since the 1991 National Institutes of Health consensus statement on eligibility for bariatric surgery,⁹ more

information has become available on the safety and efficacy of bariatric surgery in higher-risk populations such as patients with poorly controlled type 2 diabetes,¹⁰ yet the literature for bariatric surgery in patients with HF has remained sparse and without prospective data. Based on limited data, a Consensus Statement from the Heart Failure Society of America recommended consideration of bariatric surgery for selected patients with a BMI ≥ 35 kg/m² and NYHA functional class II-III HF with or without a left ventricular assist device, within an experienced multidisciplinary team.¹¹

Notable in the current study is the dramatic excess in-hospital mortality for patients with baseline HF, particularly for those with systolic HF. The 10.1% postoperative mortality for patients with systolic HF is much higher than anticipated for bariatric surgery candidates in general and is an important finding for cardiologists, bariatric surgeons, and patients to be aware of during shared decision making regarding obesity management options. As anticipated, the risk in laparoscopic surgery is overall lower, but HF patients undergoing laparoscopic surgery still carry excess of mortality when compared to non-HF patients. Careful candidate selection, meticulous presurgical optimization of cardiovascular status, and an experienced multispecialty surgical and cardiology team are likely to be essential features for successful outcomes for patients with HF considering bariatric surgery.

To our knowledge, this is the largest real-world analysis of bariatric surgery in patients with HF, yet limitations of this analysis should be acknowledged. First, observational data cannot prove cause-effect relationships and may be subject to residual or unmeasured confounding. Second, the diagnoses of HF and other comorbidities are dependent upon ICD-9 coding availability and accuracy. It is possible that the non-HF group may have included

some patients with HF; however, patients with significant HF were likely to be appropriately coded. Furthermore, ejection fraction parameters are not reported in this database. To avoid misinterpretation of the data, we maintained the diagnosis of systolic and diastolic as they were originally reported in the database. Third, outcome measures from the NIS relate only to in-hospital outcomes and do not capture longer-term follow-up. Lastly, details related to hospital expertise or case volume were not available for either bariatric surgery or HF cardiology care, and it is possible that in-hospital risk was successfully mitigated at select centers.

As compared with the general population of patients receiving bariatric surgery, HF can be associated with an excess risk of early postoperative complications and in-hospital mortality. These potential risks should prompt shared decision-making between patients and clinicians when considering bariatric surgery in the setting of concurrent HF. Prospective randomized trials are urgently needed to define appropriate candidate selection and enable stakeholders to balance potential long-term health benefits against early procedural risks in HF patients.

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