Outcomes in Cardiogenic Shock from Acute Coronary Syndrome Depending on Severity of Obesity

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We reviewed 54,044 adult cases of cardiogenic shock (CS) accompanying acute coronary syndrome from the 2005 to 2014 Nationwide Inpatient Sample. We evaluated outcomes among patients who were nonobese, obese (body mass index 30.0 to 39.9 kg/m^2) and extremely-obese (body mass index ≥40 kg/m^2). A multivariate analysis was performed to assess their impact on in-hospital mortality. There were 3,602 (6.6%) and 1,610 (2.9%) admissions among patients who were obese and extremely-obese. Those obese and extremely-obese were younger compared with the nonobese (62.7 vs 61.2 vs 68.8 years, respectively; p <0.01) but had significantly greater comorbidity burden. CS patients who were not-obese were most likely to have an associated ST elevation myocardial infarction, compared with the obese and extremely-obese (67.7% vs 65.9% vs 60.7%; p <0.01). Compared to the nonobese, patients who were obese had higher rates of percutaneous coronary intervention (55.8% vs 51.5%; p <0.01) and coronary artery bypass grafting (24.0% vs 16.0%; p <0.01) whereas those extremely-obese had higher coronary artery bypass grafting rates (23.9% vs 16.0%; p <0.01) but similar percutaneous coronary intervention rates (51.1% vs 51.5%; p = 0.74). Short-term mechanical support use was lowest among the nonobese followed by the extremely-obese and obese. Adjusted analysis revealed that obesity predicted less (adjusted odd ratio 0.82, 95% confidence interval 0.76 to 0.90) and extreme-obesity predicted higher in-hospital mortality (adjusted odds ratio 1.17, 95% confidence interval 1.05 to 1.32) compared with the nonobese. In conclusion, obesity and extreme-obesity are associated with greater comorbidity burden among ACS related CS admissions. Obesity predicted less in-hospital mortality, whereas extreme obesity was associated with elevated in-hospital mortality. **(Am J Cardiol 2019;123:1267−1272)**

One in 3 adult Americans is obese and 1 in 13 is extremely obese.[1] Cardiogenic shock (CS) is the leading cause of mortality among those who have an acute myocardial infarction (AMI). While the obesity paradox has been reported in several cardiovascular disorders including in CS, it remains unknown whether this advantage extends to the extremely obese.

Methods

We reviewed 54,044 cases of CS (ICD-9CM code 785.51) accompanying acute coronary syndrome (ACS, ICD-9CM codes 410, 411.1) from the Nationwide Inpatient Sample (NIS) between 2005 and 2014 among adults aged ≥18 years. The NIS is the largest, publicly available, all-payer inpatient database in the United States comprising of discharge-level data from roughly 8 million hospitalizations and approximates a stratified sample of 20% of community hospitals in the United States. We sought to delineate the relationship between performance of revascularization, short-term mechanical circulatory support (MCS) use, and rate of hospital mortality among patients who were nonobese, obese (ICD-9CM code 278.00 i.e. body mass index (BMI) 30.0 to 39.9 kg/m^2) and extremely obese (ICD-9CM codes 278.01, 278.03 i.e. BMI ≥40 kg/m^2). Standard statistical methods were implemented as in previous studies using NIS data using IBM SPSS 23.0 (Armonk, New York).[2−3] Pearson's chi-square test and one way analysis of variance test was used for analysis of categorical and continuous variables, respectively. Additionally, we performed a risk-adjusted mortality analysis comparing these patient groups using a multivariate regression model accounting for patient demographics, hospital/admission characteristics and underlying comorbidities.

Results

There were 3,602 (6.6%) and 1,610 (2.9%) admissions within the patient populations who were obese and extremely obese, respectively. Nonobese CS patients were most likely to have an associated ST elevation myocardial infarction, compared with the obese and nonobese (67.7% vs 65.9% vs 60.7%, respectively; p <0.01). Concordant

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See page 1272 for disclosure information.

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Table 1
Baseline characteristics among patients within different weight-based categories admitted with acute coronary syndrome related cardiogenic shock

Characteristics	Acute coronary syndrome associated cardiogenic shock			p value
	Non obese (n = 48,834)	Obese (n = 3,602)	Morbidly obese (n = 1,610)	
Age (years)	68.8 ± 13.3	62.7 ± 11.6	61.2 ± 11.2	<0.001
Age (years)				
18-50	9.2%	14.4%	16.0%	<0.001
51-65	31.2%	44.8%	48.5%	
>65	59.6%	40.8	35.5%	
Weekend admission	27.1%	26.7%	26.7%	0.772
Elective admission	5.9%	5.8%	5.7%	0.92
Women	36.9%	39.3%	43.3%	<0.001
Race				
White	63.2%	69.3%	68.6%	<0.001
Black	6.0%	7.2%	8.5%	
Hispanic	6.9%	7.1%	8.0%	
Others	23.8%	16.5%	8.0%	
Payer information				
Medicare	59.3%	45.9%	46.1%	<0.001
Medicaid	6.9%	8.5%	10.8%	
Private insurance	24.2%	33.2%	31.0%	
Self-pay	6.2%	8.1%	8.4%	
No charge	0.5%	0.6%	0.6%	
Other	2.9%	3.6%	3.0%	
Bedsize of hospital				
Small	8.2%	7.3%	5.9%	0.007
Medium	21.7%	21.5%	22.2%	
Large	70.1%	71.2%	72.0%	
Location & teaching status of hospital				
Rural	6.6	4.7%	6.4%	<0.001
Urban teaching	39.8%	40.7%	41.7%	
Urban nonteaching	53.6%	54.6%	51.9%	
Cost of stay (mean US dollars)	130,280	150,373	158,722	0.001
Length of stay (days)	8.5 ± 10.8	8.6 ± 8.8	8.8 ± 8.7	<0.001
All Patient defined DRG: severity of illness subclass				
1	0.1%	0.0%	0.0%	<0.001
2	0.8%	0.5%	0.9%	
3	15.7%	16.7%	13.1%	
4	83.4%	82.8%	86.0%	
Alcohol abuse	3.8%	4.1%	3.0%	0.168
Deficiency anemias	17.5%	21.8%	19.9%	<0.001
Rheumatoid arthritis/collagen vascular diseases	1.8%	2.1%	1.9%	0.451
Chronic blood loss anemia	1.5%	1.8%	1.2%	0.201
Chronic pulmonary disease	21.5%	25.1%	29.9%	<0.001
Coagulopathy	13.2%	15.0%	13.9%	0.008
Drug abuse	1.8%	2.1%	2.0%	0.407
Hypertension (combined uncomplicated and complicated)	52.1%	68.5%	70.9%	<0.001
Diabetes mellitus (combined uncomplicated and complicated)	30.4%	53.6%	63.4%	<0.001
Lipid disorders	36.3%	57.1%	55.3%	<0.001
Hypothyroidism	7.5%	9.8%	11.2%	<0.001
Liver disease	1.5%	1.6%	2.1%	0.157
Lymphoma	0.5%	0.2%	0.2%	0.006
Metastatic cancer	1.0%	0.4%	0.2%	<0.001
Pulmonary circulation disorders	0.2%	0.2%	0.8%	<0.001
Peripheral vascular disorders	11.9%	13.2%	13.4%	0.015
Solid tumor without metastasis	1.6%	0.8%	0.8%	<0.001
Valvular disease	0.7%	0.7%	0.7%	0.966
Chronic kidney disease	17.5%	21.3%	26.4%	<0.001
Prior myocardial infarction	7.2%	9.4%	10.0%	<0.001

(*continued*)

Table 1 (*Continued*)

Characteristics	Acute coronary syndrome associated cardiogenic shock			
	Non obese (n = 48,834)	Obese (n = 3,602)	Morbidly obese (n = 1,610)	p value
Prior stroke	4.9%	4.4%	5.3%	0.326
Acute kidney injury	37.1%	39.6%	45.0%	<0.001
ST elevation myocardial infarction	67.7%	65.9%	60.7%	<0.001
Current or past smoker	26.6%	36.6%	36.8%	<0.001
Atrial fibrillation or flutter	24.5%	23.3%	24.3%	0.311
Sepsis	10.7%	8.9%	11.1%	0.002
Ventilator use	44.8%	48.8%	53.9%	<0.001
Vasopressor	6.5%	7.1%	7.8%	0.045
Fluid and electrolyte disorders	41.7%	44.8%	45.3%	<0.001
Ischemic stroke	2.6%	2.1%	1.7%	0.023
Hemorrhagic stroke /intracranial bleeding	0.5%	0.4%	0.2%	0.311
Percutaneous coronary intervention	51.5%	55.8%	51.1%	<0.001
Coronary artery bypass grafting	16.0%	24.0%	23.9%	<0.001
Short term mechanical circulatory support*	46.3%	53.2%	47.9%	<0.001

Continuous data expressed as mean ± standard deviation.

AMI = acute myocardial infarction; SD = standard deviation; DRG = diagnosis related group.

* Intraaortic balloon pump, extracorporeal membrane oxygenation, impella/TandemHeart use.

with these findings, the rate for CS accompanying a non-ST elevation myocardial infarction/unstable angina pectoris was highest among the extremely obese. Patients who were either obese or extremely obese were younger compared with the nonobese (mean age in years 62.7 vs 61.2 vs 68.8, respectively; p <0.01) but had a markedly higher rate of comorbidities including hypertension, diabetes hyperlipidemia, and chronic kidney disease among others (Table 1). Compared to the nonobese, patients who were obese had higher rates of percutaneous coronary intervention (55.8% vs 51.5%; p <0.01) and coronary artery bypass grafting (CABG) (24.0% vs 16.0%; p <0.01) whereas those extremely obese had higher CABG rates (23.9% vs 16.0%; p <0.01) but similar percutaneous coronary intervention rates (51.1% vs 51.5%; p = 0.74) as noted in Figure 1. MCS use was lowest among the nonobese followed by the extremely obese and obese (46.5% vs 47.9% vs 53.2%. respectively; p <0.01). A sub-analysis revealed that these MCS trends were mostly driven by intra-aortic balloon pump use (>97%). It may be noted that the baseline in-hospital mortality rate was highest among CS patients who were nonobese, compared with both the extremely obese (41.6% vs 40.0%; p <0.01) and obese (41.6% vs 32.1%; p <0.01). Following multivariate adjustment (Figure 2 and Table 2), presence of obesity among CS admissions independently predicted less in-hospital mortality (adjusted odds ratio 0.82, 95% confidence interval 0.76 to 0.90; p <0.01) whereas extreme obesity was associated with significantly increased hospital mortality (adjusted odds ratio 1.17, 95% confidence interval 1.05 to 1.32; p <0.01).

Discussion

Our study showed that whereas obesity and extreme obesity are associated with greater comorbidity burden among ACS related CS admissions, obesity was associated with less adjusted hospital mortality but extreme obesity predicted an elevated in-hospital mortality. Use of both MCS and revascularization were higher among patients who were compared with the nonobese and extremely obese. The 'obesity paradox' has been demonstrated in several large observational cohorts including patients presenting with AMI and recent data by Chatterjee et al[4], has extended such a benefit to patients with AMI related cardiogenic shock. Despite its similarities with our design, Chatterjee et al, did not separately evaluate the patient cohort with extreme underlying obesity. Previous studies have hypothesized that several factors ranging from a younger age at presentation to a possibly attenuated inflammatory milieu and greater medication tolerability may contribute to the short-term survival benefit seen with cardiovascular disorders among the obese.[5,6] Our analysis is concordant with available obesity related cardiovascular disease literature where the rate of revascularization and MCS use was highest among the patient population that was obese. However, most of the previously mentioned studies do not delineate the differential impact of extreme obesity on outcomes. Dhoot et al[7], noted higher revascularization rates among those with morbid obesity in the setting of AMI and lower hospital mortality rates even after adjustment. In an analysis of over 8,800 critically ill patients, extreme obesity was associated with no difference in risk-adjusted 60-day mortality but a longer ICU stay and duration of mechanical ventilation compared with those with normal weight.[8] A pooled analysis of 20 prospective studies revealed markedly elevated all-cause mortality with morbid obesity compared with those with normal weight.[9] These data highlight the variability in extreme-obesity related outcomes depending on the disease under study and duration of follow-up. Our study is the first to note that in patients with CS complicating ACS, the rate of revascularization (driven by CABG) among the extremely obese was higher than the nonobese with an overall similar rate of MCS use (despite higher Impella/TandemHeart and Extracorporeal Membrane Oxygenation use among the extremely obese).

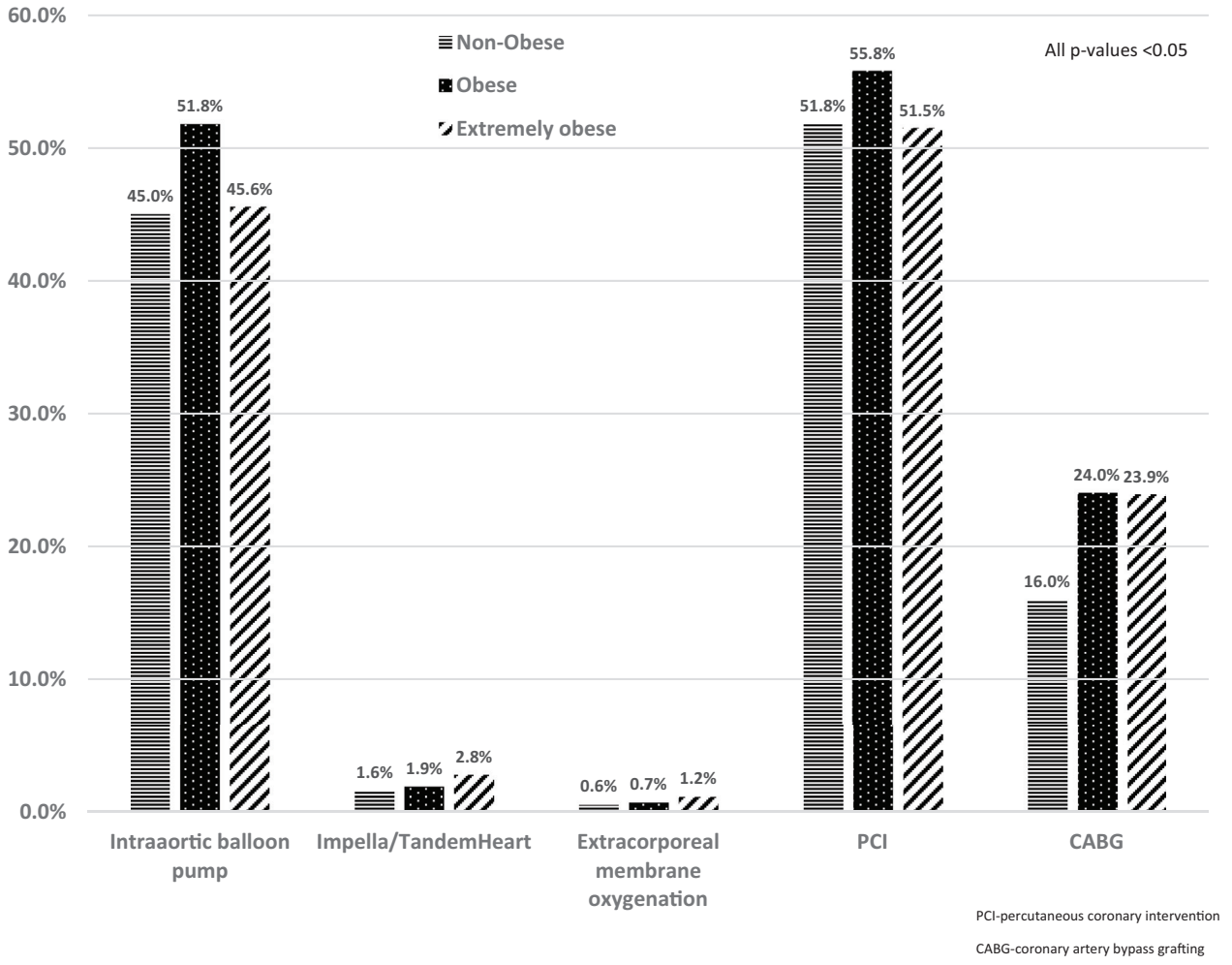

Figure 1. Use of coronary revascularization techniques and short-term mechanical circulatory support use among patients within different weight based categories.

Patients with extreme-obesity had a marginally longer stay, cost of stay, greater need for ventilator support, and a likely more severe presentation of disease which may be responsible for the higher rate of hospital mortality among the extremely obese compared with the nonobese.

The accuracy of these findings is limited by the use ICD-9CM coding for identification of the categories for obesity classification as BMI data is not available within database. Important clinical markers including vital signs, temporal aspects of presentation, etiology of mortality, defibrillator/resynchronization therapy use, baseline medications, and echocardiographic parameters among others could not be adjusted for. It remains the first study to demonstrate that the 'obesity paradox' is reversed among patients presenting

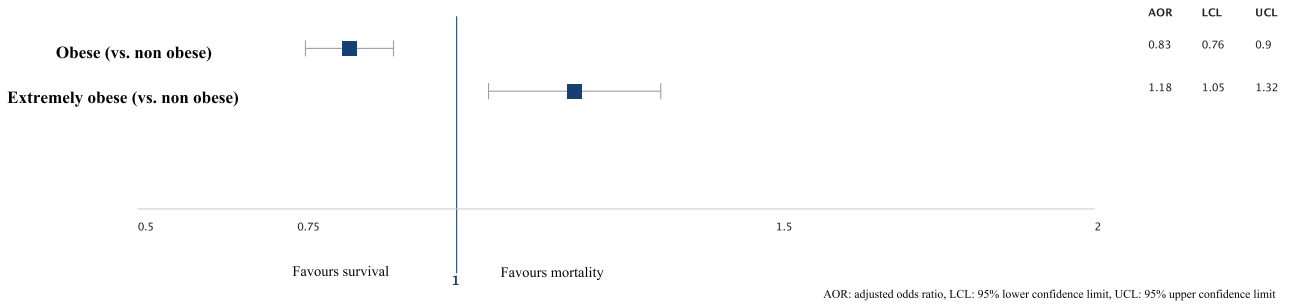

Figure 2. Forest plot representing risk adjusted prediction of hospital mortality among the obese and extremely obese patients in comparison to the nonobese.

Table 2
Multivariable predictors for hospital mortality among patients admitted for acute coronary syndrome related cardiogenic shock

Variable	Adjusted odds ratio	95% confidence interval upper limit	95% confidence interval lower limit	p value
Age (years)				
18-50	Referent	Referent	Referent	
51-65	1.376	1.269	1.491	<0.001
>65	2.691	2.461	2.943	<0.001
Weekend admission	1.026	0.982	1.072	0.258
Elective admission	0.834	0.763	0.911	<0.001
Female sex	1.162	1.113	1.212	<0.001
Payer information				
Medicare	Referent	Referent	Referent	
Medicaid	0.838	0.764	0.919	<0.001
Private insurance	0.746	0.702	0.793	<0.001
Self-pay	1.163	1.059	1.278	0.002
No charge	0.768	0.579	1.020	0.068
Other	0.899	0.790	1.023	0.105
Race				
White	Referent	Referent	Referent	
Black	0.949	0.872	1.033	0.224
Hispanic	0.937	0.864	1.016	0.116
Others	0.944	0.898	0.992	0.022
Obesity status				
Nonobese	Referent	Referent	Referent	
Obese	0.829	0.763	0.901	<0.001
Morbidly obese	1.177	1.050	1.320	0.005
Bedsize of hospital				
Small	Referent	Referent	Referent	
Medium	0.987	0.911	1.070	0.754
Large	0.892	0.829	0.960	0.002
Location and teaching status of hospital				
Rural	Referent	Referent	Referent	
Urban teaching	0.886	0.817	0.962	0.004
Urban nonteaching	0.881	0.812	0.956	0.002
Comorbidities				
Alcohol abuse	0.695	0.622	0.778	<0.001
Deficiency anemias	0.667	0.633	0.704	<0.001
Rheumatoid arthritis/collagen vascular diseases	0.994	0.860	1.149	0.940
Chronic blood loss anemia	0.483	0.409	0.571	<0.001
Chronic pulmonary disease	0.792	0.754	0.832	<0.001
Coagulopathy	1.005	0.945	1.070	0.863
Drug abuse	0.748	0.635	0.881	0.001
Hypertension (combined uncomplicated and complicated)	1.093	1.047	1.141	<0.001
Hypothyroidism	1.014	0.943	1.089	0.714
Liver disease	1.454	1.236	1.709	<0.001
Lymphoma	1.108	0.853	1.439	0.441
Metastatic cancer	1.815	1.491	2.211	<0.001
Pulmonary circulation disorders	1.178	0.766	1.811	0.456
Peripheral vascular disorders	1.335	1.256	1.419	<0.001
Solid tumor without metastasis	1.164	0.998	1.356	0.053
Valvular disease	0.762	0.588	0.988	0.040
Chronic kidney disease	1.072	1.014	1.133	0.014
Prior myocardial infarction	1.178	1.094	1.268	<0.001
Prior stroke	1.461	1.335	1.599	<0.001
Diabetes mellitus (combined uncomplicated and complicated)	1.021	0.976	1.067	0.371
Acute kidney injury	1.728	1.653	1.806	<0.001
ST elevation myocardial infarction	1.571	1.500	1.646	<0.001
Current or past smoker	0.861	0.821	0.904	<0.001
Atrial fibrillation or flutter	0.898	0.857	0.941	<0.001
Sepsis	1.147	1.072	1.227	<0.001
Lipid disorders	0.706	0.676	0.738	<0.001
Ventilator use	3.053	2.929	3.182	<0.001
Vasopressor use	1.250	1.157	1.349	<0.001

(*continued*)

Table 2 (*Continued*)

Variable	Adjusted odds ratio	95% confidence interval upper limit	95% confidence interval lower limit	p value
Fluid and electrolyte disorders	1.230	1.179	1.283	<0.001
Ischemic stroke	1.136	0.994	1.299	0.062
Hemorrhagic stroke /intracranial bleeding	2.724	1.945	3.815	<0.001
Percutaneous coronary intervention	0.359	0.343	0.377	<0.001
Coronary artery bypass grafting	0.239	0.223	0.257	<0.001
Short term mechanical circulatory support*	1.193	1.141	1.247	<0.001

* Intraaortic balloon pump, extracorporeal membrane oxygenation, impella/TandemHeart use.

with ACS related CS and underlying extreme obesity. It does need further validation in separate patient cohorts to facilitate a better understanding of this phenomenon.

Disclosures

All authors have no conflict of interest.

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