Relation of Obesity to Survival After In-Hospital Cardiac Arrest

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Previous studies have shown that obesity is paradoxically associated with improved outcomes in many cardiovascular (CV) disease states; however, whether obesity affects survival after in-hospital cardiac arrest (IHCA) has not been well examined. We queried the 2003 to 2011 Nationwide Inpatient Sample databases to identify all patients aged ≥18 years who underwent cardiopulmonary resuscitation for IHCA. Obese patients were identified using the co-morbidity variable for obesity, as defined in Nationwide Inpatient Sample databases. Survival to hospital discharge was compared between obese and nonobese patients using multivariate regression models. Of 836,289 patients with IHCA, 67,216 (8.0%) were obese. Obese patients were younger and more likely to be women compared with nonobese patients. Despite being younger, obese patients had significantly higher prevalence of most CV co-morbidities such as dyslipidemia, coronary artery disease, previous myocardial infarction, heart failure, diabetes mellitus, hypertension, peripheral vascular disease, and chronic renal failure (p <0.001 for all). Obese patients were more likely to have ventricular tachycardia or ventricular fibrillation as the initial cardiac arrest rhythm (22.3% vs 20.9%; p <0.001). After multivariate risk adjustment, obese patients had improved survival to hospital discharge compared with nonobese patients (31.4% vs 24.1%; unadjusted odds ratio 1.44, 95% CI 1.42 to 1.47, p <0.001; adjusted odds ratio 1.15, 95% CI 1.13 to 1.17, p <0.001). Similar results were seen in patients with CV or non-CV conditions as the primary diagnosis and in those with ventricular tachycardia/ventricular fibrillation or pulseless electrical activity/asystole as the cardiac arrest rhythm. In conclusion, this large retrospective analysis of a nationwide cohort of patients with IHCA demonstrated higher risk-adjusted odds of survival in obese patients, consistent with an "obesity paradox." © 2016 Elsevier Inc. All rights reserved. (Am J Cardiol 2016;118:662−667)

Obesity is a significant health problem affecting over 1/3 of the adult US population, leading to utilization of over 145 billion US dollars in annual health care costs.[1,2] Obesity is an important cardiovascular (CV) risk factor and is associated with increased prevalence of several CV conditions, notably hypertension, coronary artery disease (CAD), left- and right-sided heart failure, and arrhythmias.[3] Although its contributory role as a CV risk factor is well established,

research over the last decade has suggested that obesity may be protective in patients with established cardiac disease.[4,5] Several studies have described improved clinical outcomes in overweight and obese patients with hypertension, stable CAD, acute coronary syndromes, heart failure, and peripheral artery disease, a phenomenon termed as the "obesity paradox."[6−8] However, data on the association of obesity with outcomes after cardiac arrest are largely restricted to small, single-center, out-of-hospital cardiac arrest (OHCA) cohorts and are conflicting as to whether the "obesity paradox" exists in this population.[9,10] In-hospital cardiac arrest (IHCA) is common and is associated with poor prognosis.[11] A previous study on patients with IHCA found survival to discharge to be higher in the obese only among those with shockable rhythms but not in those with non-shockable rhythms.[12] The purpose of this investigation was to examine the association of obesity with survival to hospital discharge using a large, unselected cohort of patients with IHCA included in the Nationwide Inpatient Sample (NIS) databases from 2003 to 2011.

Methods

Data were obtained from the NIS files from 2003 to 2011. The NIS is sponsored by the Agency for Healthcare

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See page 666 for disclosure information.

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Research and Quality (AHRQ) as a part of the Healthcare Cost and Utilization Project and is used by researchers and policymakers to analyze national trends in health care utilization and outcomes.[13,14] NIS is the largest all-payer inpatient care database publicly available in the US and includes data from over 8 million hospital stays from ~1,000 hospitals, approximating a 20% stratified sample of discharges from US hospitals. Data are drawn from "all non-Federal, short-term, general, and other specialty hospitals" in participating states (n = 46 in 2011), representing over 95% of the US population. Criteria used for stratified sampling of the hospitals include bed size, teaching status, urban or rural location, geographic region, and ownership/control. Discharge weights are included for each patient discharge record and can be used to obtain national estimates.[15]

We used the *International Classification of Diseases, Ninth Edition, Clinical Modification* (ICD-9-CM) codes 99.60 or 99.63 to identify all patients aged ≥18 years undergoing cardiopulmonary resuscitation for IHCA (n = 838,951). Previous studies using NIS data have used this approach to accurately identify patients with IHCA.[11,16] Obese patients were identified using the AHRQ-defined co-morbidity measure, CM_Obese. AHRQ co-morbidities were described by Elixhauser et al[17] using ICD-9-CM diagnoses and the diagnosis-related group (DRG) in effect on the discharge date. Variables are assigned as co-morbidities by restricting the search to those secondary diagnoses that are not directly related to the principal diagnosis and the DRG assignment of each patient. The definition of obesity includes the following ICD-9-CM codes: 278.0, 278.00, 278.01, 278.03, 649.10-649.14, 793.91, V85.30-V85.39, V85.41-V85.45, V85.54 and excludes the following DRGs: 288, 296-298, 619-621, and 640-641.[18] We excluded records with missing data on obesity (n = 2,662), giving us a final study sample of 836,289 patients with IHCA. Patients with ventricular tachycardia (VT) or ventricular fibrillation (VF) were identified by ICD-9-CM code 427.1 or 427.41, respectively. Discharge records without either of these codes were presumed to have pulseless electrical activity (PEA) or asystole as the cardiac arrest rhythm. Patients with a primary CV discharge diagnosis were identified using Clinical Classification Software codes 96-121 that include ischemic heart disease, heart failure, arrhythmias, cerebrovascular disease, and other CV conditions.[19] All other records were classified as having a primary non-CV diagnosis.

Our outcome of interest was survival to hospital discharge. We included age, gender, primary expected payer, weekday versus weekend admission, all Elixhauser co-morbidities (except obesity), and other clinically relevant co-morbidities (smoking, dyslipidemia, known CAD, family history of CAD, previous myocardial infarction, previous transient ischemic attack (TIA)/stroke, previous percutaneous coronary intervention, previous coronary artery bypass grafting, previous cardiac arrest, a family history of sudden cardiac death, carotid artery disease, dementia, and atrial fibrillation) as baseline patient characteristics.[17,18] A list of ICD-9-CM and Clinical Classification Software codes used to identify co-morbidities is provided in Supplementary Table 1. Hospital characteristics that were used included geographical region (Northeast, Midwest, South, and West), number of beds (small, medium, and large), location (rural and urban), and teaching status.

Weighted data were used for all analyses. For descriptive analyses, patient and hospital characteristics were compared between obese and nonobese patients using the Pearson chi-square test for categorical variables and the Student *t* test for continuous variables. Categorical variables are expressed as percentages and continuous variables as mean ± SD. To examine differences in survival to hospital discharge between obese and nonobese patients with IHCA, a multivariate logistic regression model was constructed with generalized estimating equations using exchangeable working correlation matrix to account for nested outcomes within hospitals. Variables included in the regression model included demographics (age, gender, and race), primary expected payer, weekday versus weekend admission, all Elixhauser co-morbidities (except obesity), other clinically relevant co-morbidities, initial cardiac arrest rhythm, and hospital characteristics (region, bed size, location, and teaching status). Survival to hospital discharge was also examined separately in patients with a primary CV or non-CV diagnosis and in patients with VT/VF or PEA/asystole as the cardiac arrest rhythm. Data were complete on all covariates except race (15.7% missing), hospital characteristics (0.5% missing), primary expected payer (0.2% missing), and gender (<0.1% missing). Furthermore, different regions do not have uniform inclusion criteria for the "other" race (2.3%) category, which, therefore was also treated as missing. We performed multiple imputations to impute missing values using the fully conditional specification method. Results with and without imputation were similar, so only the former are presented. Statistical analyses were performed using IBM SPSS Statistics 21.0 (IBM Corp, Armonk, New York). Odds ratios (ORs) and 95% CIs are used to report the results of regression analyses. We used a 2-sided p value of <0.05 to define statistical significance.

Results

From 2003 to 2011, of 836,289 records with IHCA included in our study, 67,216 (8.0%) had a documented diagnosis of obesity. Obese patients were significantly younger and more likely to be women compared with nonobese patients. Obese patients had a significantly higher prevalence of most co-morbid conditions including smoking, dyslipidemia, diabetes mellitus, hypertension, heart failure, chronic pulmonary diseases, chronic renal failure, known CAD, previous myocardial infarction, previous TIA/stroke, deficiency anemias, previous cardiac arrest, hypothyroidism, and fluid/electrolyte disorders (p <0.001 for all). Obese patients were more likely to have VT/VF (22.3% vs 20.9%) and less likely to have PEA/asystole (77.7% vs 79.1%) as the cardiac arrest rhythm in comparison with nonobese patients. Obese patients with IHCA were also more likely to have a primary CV diagnosis (35.8% vs 32.6%; Table 1).

In the overall study cohort, survival to hospital discharge was 24.7%. Obese patients had higher rates of survival to hospital discharge compared with nonobese patients (31.4% vs 24.1%; unadjusted OR 1.44, 95% CI 1.42 to 1.47, p <0.001). Even after adjustment for demographics,