Etiologies, Predictors, and Economic Impact of 30-Day Readmissions Among Patients With Peripartum Cardiomyopathy

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Peripartum cardiomyopathy (PPCM) is a pregnancy-associated cause of heart failure. Given the significant impact of heart failure on healthcare, we sought to identify etiologies and predictive factors for readmission in PPCM. We queried the 2013 to 2014 National Readmissions Database to identify patients admitted with a diagnosis of PPCM. Patients who were readmitted within 30 days were evaluated to identify etiologies and predictors of readmission. We identified 6,977 index admissions with PPCM. Of the 6,880 (98.6%) patients who survived the index hospitalization, 30-day readmission rate was 13%. Seventy-six percent of readmitted patients were admitted once, and the other 24% were readmitted at least twice within 30 days of discharge. Length of stay was ≥8 days (adjusted odds ratio [aOR] 2.80, 95% confidence interval [CI] 2.08 to 3.77), multiparity (aOR 2.07, 95% CI 1.09 to 3.92), coronary artery disease (aOR 2.28, 95% CI 1.42 to 3.67), and long-term anticoagulation use (aOR 2.51, 95% CI 1.73 to 3.64) were independently associated with increased risk of 30-day readmission. Among the readmissions, 48% were due to cardiac causes, where PPCM and related complications (24%) were the most common cardiac cause followed by heart failure (16%). The annual cost of stay for index admissions was $64.2 million (average cost for index admission was $16,892). The annual charges attributed to readmission within 30 days were ≈$9 million. Cardiac etiologies were the most common cause for 30-day readmissions in PPCM patients, with a readmission rate of 13%. Long-term anticoagulation use, multiparity, coronary disease and length of stay predicted higher 30-day readmission. **(Am J Cardiol 2018;■■:■■–■■)**

Peripartum cardiomyopathy (PPCM) presents as a dilated cardiomyopathy in the last month of pregnancy and up to 6 months after delivery.[1] Despite current advances in maternal and perinatal care, the incidence of PPCM in the United States is approximately 1 in 1,000 births, with the incidence rate showing an increasing trend in recent years.[2] Adverse events such as persistent severe cardiomyopathy can be as high as 13% at 1 year.[3] There are significant regional and racial differences, especially among African-Americans who experience higher rates of PPCM and related mortality.[4] Heart failure hospital readmission rates between dilated cardiomyopathy and PPCM have been similar even though these are distinct entities of heart failure.[5] An opportunity thus arises to make an effort, to improve outcomes in the PPCM population, as the overall prognosis is thought to be better when compared with dilated cardiomyopathy.[5] Given the general trend towards improving health-care outcomes and expenditures by decreasing heart failure rehospitalizations, it is vital to analyze which modifiable risk factors influence subsequent hospital readmissions in PPCM. Addressing these potential modifiable risk factors might assist in decreasing the overall burden of heart failure in this population.

Methods

The study cohort was derived from the Healthcare Cost and Utilization Project's National Readmission Database (NRD) of 2013 and 2014, sponsored by the Agency for Healthcare Research and Quality. The NRD is one of the largest publicly available all-payer inpatient databases in the United States, including data on approximately 28 million discharges in the year 2013, estimating >50 million discharges from 21 states with reliable, verified linkage numbers. The NRD represents 49% of total US hospitalizations. Patients were tracked using variable "NRD_visitlink," and the time between 2 admissions was calculated by subtracting the variable "NRD DaysToEvent." Time to readmission was calculated by subtracting the length of stay (LOS) of index admissions from the time between 2 admissions. National estimates were

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produced using sampling weights provided by the sponsor. The details regarding the NRD data are available online (Health Cost and Utilization Project, NRD Description of Data Elements, https://www.hcup-us.ahrq.gov/db/nation/nrd/nrddde.jsp, access date February 22, 2017).

We queried the NRD database for patients admitted with PPCM (ICD-9-CM code 674.5x). We excluded patients with age <18 years and those missing data for age or mortality. We also excluded index admissions from the months of December 2013 and December 2014, as we did not have 30 days of follow-up data for the same. We identified a total of 6,977 weighted index admissions. Patients who were readmitted to the hospital within 1 month within the same calendar year were further evaluated (n = 890). We also analyzed 1- to 6-month readmission etiologies among index admissions up to June 30 for both years of study (n = 3,746 index admissions).

The primary outcome was 30-day readmission. Readmission causes were identified by using ICD-9 codes in the primary diagnosis field. We identified and combined the ICD-9-CM codes with similar diagnoses to make clinically important groups. Within the group with index admissions for PPCM, we used ICD-9-CM codes to define additional variables and co-morbidities.

NRD variables were used to identify patients' demographic characteristics including age, gender, hospital characteristics such as bed size and teaching status, other patient-specific characteristics, primary payer, admission type, admission day, and discharge disposition. "CM_" variables identified different co-morbidities by using ICD-9-CM diagnoses and the diagnosis-related group in effect on the discharge date. These co-morbidities are not directly related to the principal diagnosis or the main reason for admission and are likely to have originated before the hospital stay. (Healthcare Cost and Utilization Project Comorbidity Software, Version 3.7. 2008, access date June 1, 2016).

All analyses were performed using the IBM SPSS Statistics for Windows, Version 23.0 (Armonk, New York). Differences between categorical variables were tested using the Pearson chi-square test and continuous variables using student's *t* test. A multivariable logistic regression model was created to assess which variables predicted 30-day readmission using hospital id as a random effect. The multivariate models for readmission included hospital-level variables such as bed size and teaching status; patient-level variables such as age groups, gender, admission day, primary payer; LOS of index admission; co-morbidities; and disposition after index admission. Patients who died at the end of index admission were excluded from the analyses.

Results

Baseline patient demographic, hospital characteristics, and in-hospital outcomes of PPCM patients who survived index hospitalization are shown in Table 1. Overall in-hospital mortality within the study group was 1.4%. A large majority of admissions occurred at large, urban hospitals. On univariate analysis, when compared with patients who were not readmitted within 30-days, those readmitted were more likely to be insured by Medicare/Medicaid, be within the lowest income quartile, be admitted to teaching hospitals, have LOS ≥5 days, have antepartum occurrence of cardiomyopathy, have additional preexisting co-morbidities, and be discharged to home with health care or discharged against medical advice (Table 1). There was no difference in smoking use, iron deficiency anemia, transient hypertension of pregnancy, preterm delivery, multiple gestation, preeclampsia or eclampsia, postpartum hemorrhage, use of vasopressors, ventricular assist device, short-term mechanical support, ICD or pacemaker implantation, and cardiac transplantation between patients who were readmitted within 30 days and those who were not.

Among the 6,880 patients who survived their index hospitalization, 890 (13%) were readmitted within 30 days. Although 76% of the readmitted patients were admitted once, the other 24% were readmitted at least twice within 30 days of discharge. Median time to first readmission was 11 days (interquartile range 4 to 19 days). Mean LOS for readmissions was 5.47 days (Figure 1). On multivariate analysis (Figure 2, Table A1), among those who survived to discharge, LOS ≥8 days (adjusted odds ratio [aOR] 2.80, 95% confidence interval [CI] 2.08 to 3.77), multiparous (aOR 2.07, 95% CI 1.09 to 3.92), multiple gestation (aOR 1.81, 95% CI 1.05 to 3.13), long-term anticoagulation use (aOR 2.51, 95% CI 1.73 to 3.64), and other factors as shown in were independently associated with higher risk of 30-day readmission. In contrast, private insurance (aOR 0.48, 95% CI 0.34 to 0.66) and postpartum occurrence (aOR 0.25, 95% CI 0.18 to 0.35) were independently associated with a lower risk of 30-day readmission (all p values <0.05).

Among all readmissions, 48% were due to cardiac causes, where PPCM (24%) was the commonest cause, followed by heart failure (16%). Complications of pregnancy, childbirth, and puerperium including infection and renal and hypertensive disorders comprised 25% of causes (Figure 3 and Table A2).

Two percent of readmitted patients experienced in-hospital mortality during their readmission within 30-days. The annual aggregate charges attributed to readmission within 30 days were ≈$9 million (annual cost of stay for index admissions was $64 million, and average cost for index admission was $16,892). The first 30-day readmission accounted for 12.4% of total costs involved (total cost = index + readmission cost) with an average cost per readmission of $16,708.

From the total of 3,746 index admissions that survived, which occurred between January 1 and June 30, a total of 757 patients (20%) were readmitted between 1 and 6 months from discharge. Hospital mortality was an additional 4.4% among these readmitted patients. 2.8% of the patients received cardiac transplantation, and another 3.7% received permanent ventricular assist device between 1 and 6 months following index admission for PPCM. The most common cause for readmission from 1 to 6 months was for cardiovascular etiologies accounting for 46% of all readmissions. Admission for heart failure accounted for 30% of the readmissions in this time period.

Discussion

We report recent data from a large US database on the etiologies and predictors of readmission for patients with PPCM. There are 3 important points from this study. First, of the patients who survived index hospitalization, 13% were