ORIGINAL RESEARCH

Temporal Trends in Incidence and Outcomes of Peripartum Cardiomyopathy in the United States: A Nationwide Population-Based Study

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***Background*—**The reported incidence of peripartum cardiomyopathy (PPCM) in the United States varies widely. Furthermore, limited information is available on the temporal trends in incidence and outcomes of PPCM.

***Methods and Results*—**We queried the 2004-2011 Nationwide Inpatient Sample databases to identify all women aged 15 to 54 years with the diagnosis of PPCM. Temporal trends in incidence (per 10 000 live births), maternal major adverse events (MAE; defined as in-hospital mortality, cardiac arrest, heart transplant, mechanical circulatory support, acute pulmonary edema, thromboembolism, or implantable cardioverter defibrillator/permanent pacemaker implantation), cardiogenic shock, and mean length of stay were analyzed. From 2004 to 2011, we identified 34 219 women aged 15 to 54 years with PPCM. The overall PPCM rate was 10.3 per 10 000 (or 1 in 968) live births. PPCM incidence increased from 8.5 to 11.8 per 10 000 live births ($P_{trend}<0.001$) over the past 8 years. MAE occurred in 13.5% of patients. There was no temporal change in MAE rate, except a small increase in in-hospital mortality and mechanical circulatory support ($P_{trend}<0.05$). Cardiogenic shock increased from 1.0% in 2004 to 4.0% in 2011 ($P_{trend}<0.001$). Mean length of stay decreased during the study period.

***Conclusion*—**From 2004 to 2011, the incidence of PPCM has increased in the United States. Maternal MAE rates overall have remained unchanged while cardiogenic shock, utilization of mechanical circulatory support, and in-hospital mortality have increased during the study period. Further study of the mechanisms underlying these adverse trends in the incidence and outcomes of PPCM are warranted. **(*J Am Heart Assoc*. 2014;3:e001056 doi: 10.1161/JAHA.114.001056)**

Key Words: incidence • major adverse events • outcomes • peripartum cardiomyopathy • trends

Peripartum cardiomyopathy (PPCM) is a form of idiopathic dilated cardiomyopathy that presents in women during the latter part of pregnancy or the first several months after delivery. Diagnostic criteria used to define PPCM include: (1) the development of heart failure (HF) in the last month of pregnancy or within 5 months post-partum; (2) the absence of another identifiable cause of HF; (3) the absence of recognizable heart disease prior to the last month of pregnancy; and (4) left ventricular systolic dysfunction demonstrated by classical echocardiography criteria (left ventricular ejection fraction <45%, fractional shortening <30%, or both, with or without an LV end-diastolic dimension >2.7 cm/m^2 body surface area).[1] The HF Association of the European Society of Cardiology Working Group on PPCM recently expanded the definition to "an idiopathic cardiomyopathy presenting with HF secondary to left ventricular systolic dysfunction towards the end of pregnancy or in the months following delivery, where no other cause of HF is found."[2] Currently accepted risk factors associated with the development of PPCM include advanced maternal age, African-American race, chronic hypertension, preeclampsia, multiple gestations, and prolonged use of tocolytics.[3]

Prior studies have shown that the incidence of PPCM in the United States is between 1 in 1141 to 1 in 4350 live births (mean 1 in 3186 live births).[4–8] However, most of these data

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are from single center or single state/region studies and may not be representative of the national population. Therefore, the incidence of PPCM in the United States remains unknown. PPCM is associated with important short- and long-term complications, including acute pulmonary edema, cardiogenic shock requiring mechanical circulatory support, cardiopulmonary arrest secondary to HF or arrhythmias, thromboembolic complications, and death.[9,10] It is unclear if the incidence and outcomes of PPCM have remained constant or have changed over time.

The primary objective of this study was to determine the incidence and maternal complication rates of PPCM in a contemporary, real-world, nationwide population of hospitalized patients, as well as to examine the temporal trends in the incidence and outcomes of PPCM using the 2004-2011 Nationwide Inpatient Sample (NIS) databases.

Methods

Data Source

Data were obtained from the 2004 to 2011 NIS databases. The NIS, sponsored by the Agency for Healthcare Research and Quality as a part of Healthcare Cost and Utilization Project (HCUP), is the largest publicly available all-payer inpatient care database in the United States. It contains discharge-level data from approximately 8 million hospital stays per year from about 1000 hospitals designed to approximate a 20% stratified sample of hospitals from 46 participating states (in 2011) representing 97% of the US population. Criteria used for stratified sampling of hospitals include hospital ownership, patient volume, teaching status, urban or rural location, and geographic region. Inpatient stay records in the NIS include clinical and resource use information available from discharge abstracts derived from state-mandated hospital discharge reports. This study was deemed exempt by the New York Medical College Institutional Review Board, because HCUP-NIS is a public database with no personal identifying information.

Data on annual number of live births in the United States were obtained from the Centers for Disease Control and Prevention (CDC), National Center for Health Statistics, VitalStats, or CDC Wide-ranging Online Data for Epidemiologic Research (WONDER).[11,12]

Study Population

From 2004 to 2011, a total of 63 911 033 hospital records were included in the NIS, corresponding to a national estimate of 313 736 891 hospital discharges in the United States. A discharge record was classified as indicating PPCM if it included any of the International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) codes 674.50 to 674.55 (N=34 313). These ICD-9-CM codes for PPCM were introduced in October 2003 and have been used in prior studies to accurately identify PPCM cases in administrative databases.[10] For our study, we excluded women with PPCM aged <15 or >54 years (n=94) due to small patient numbers at these extremes of ages and since CDC does not report data on annual number of live births in women >54 years of age. This gave us a final study cohort of 34 219 women aged 15 to 54 years with the diagnosis of PPCM. For calculating PPCM incidence rates, live births in women aged <15 years were excluded from the denominator.

Outcome Measures

We initially studied the temporal trends in PPCM incidence rates in the overall cohort as well as pre-specified subgroups of age (15 to 19, 20 to 29, 30 to 39, and 40 to 54), race (Caucasian, African-American, Hispanic, Asian/Pacific Islander, and Native American), census region (Northeast, Midwest, South, and West), and co-morbidities previously shown to increase the risk of PPCM (chronic hypertension, pregnancy-associated hypertension, eclampsia, diabetes mellitus, tobacco use, multiparity, and multiple gestation).[2]

Next, we analyzed temporal trends in outcomes in patients with PPCM. Our primary outcome of interest was maternal major adverse events (MAE). Similar to prior studies, we defined MAE as either in-hospital mortality or complications that can be life threatening or result in long-term morbidity.[9,10] These included cardiac arrest, heart transplant, mechanical circulatory support, acute pulmonary edema, thromboembolism, or implantable cardioverter defibrillator (ICD)/permanent pacemaker (PPM) implantation. Secondary outcomes included individual components of MAE, as well as cardiogenic shock, and length of stay. The ICD-9-CM codes used to define each complication/outcome are provided in Table 1.

Patient and Hospital Characteristics

Baseline patient characteristics used included demographics (age, race, primary expected payer, weekday versus weekend admission, median household income for patient's ZIP code), and clinically relevant co-morbidities (chronic hypertension, diabetes mellitus, tobacco use, dyslipidemia, atrial fibrillation, alcohol abuse, anemia, rheumatoid arthritis/collagen vascular diseases, chronic pulmonary disease, coagulopathy, depression, drug abuse, hypothyroidism, liver disease, malignancy, fluid and electrolyte disorder, paralysis, other neurological disorders, obesity, peripheral vascular disease, psychoses, pulmonary circulation disorders, chronic kidney disease, pregnancy-associated hypertension, pre-eclampsia, eclamp-

Table 1. International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) and Clinical Classifications Software (CCS) Codes Used to Identify Co-Morbidities and Outcomes

Variable	Source	Code(s)
Co-morbidities*		
Tobacco use	ICD-9-CM	305.1
Dyslipidemia	CCS	53
Atrial fibrillation	ICD-9-CM	427.31
Pregnancy-associated HTN	ICD-9-CM	642.3x
Pre-eclampsia	ICD-9-CM	642.4x, 642.5x
Eclampsia	ICD-9-CM	642.6x
Antepartum hemorrhage	ICD-9-CM	641.0x to 641.9x
Multiparity	ICD-9-CM	659.4, V61.5
Multiple gestation	ICD-9-CM	651.0x to 651.9x, V27.2 to V27.7
Outcomes		
Cardiac arrest	ICD-9-CM	427.5, 99.60, 99.63
Heart transplant	ICD-9-CM	37.51, 33.6
Mechanical circulatory support	ICD-9-CM	37.60, 37.61, 37.62, 37.65, 37.66, 37.68, 39.65
Acute pulmonary edema	ICD-9-CM	518.4, 428.1
Thromboembolism	ICD-9-CM	451.11, 451.19, 451.81, 451.83, 451.89, 453.2, 453.4x, 453.8x, 671.3x, 671.4x, 671.5x, 415.1x, 673.2x, 557.0, 444.0x, 444.1, 444.2x, 444.8x, 593.81, 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.0x, 434.1x, 434.9x, 436, 410.0x to 410.9x, 411.1, 411.8x, 429.79
ICD implantation	ICD-9-CM	37.94, 37.95, 37.96, 37.97, 37.98, 00.51, 00.54
PPM implantation	ICD-9-CM	37.70 to 37.79, 37.80 to 37.89, 00.50, 00.52, 00.53
Cardiogenic shock	ICD-9-CM	785.51

HTN indicates hypertension; ICD, implantable cardioverter defibrillator; PPM, permanent pacemaker.
*Other co-morbidities such as chronic hypertension, diabetes mellitus, alcohol abuse, anemia, rheumatoid arthritis/collagen vascular diseases, chronic pulmonary disease, coagulopathy, depression, drug abuse, hypothyroidism, liver disease, malignancy, fluid and electrolyte disorder, paralysis, other neurological disorders, obesity, peripheral vascular disease, psychoses, pulmonary circulation disorders, and chronic kidney disease were identified using the Agency for Healthcare Research and Quality co-morbidity measures software.

sia, antepartum hemorrhage, multiparity, and multiple gestation). The ICD-9-CM and/or Clinical Classifications Software codes used to identify these co-morbidities are provided in Table 1. Hospital characteristics such as hospital region (Northeast, Midwest, South, and West), bed size (small, medium, and large), location (rural, urban), and teaching status were also included.

Statistical Analysis

Weighted data was used for all analyses. Discharge weights provided in the NIS were used to obtain national estimates of the annual number of PPCM cases, which were then used to calculate PPCM incidence rates. Standard error calculations for national estimates were made using the method recommended by the Agency for Healthcare Research and Quality.[13] We analyzed PPCM incidence rates for the overall cohort and for subgroups of age, race, census region, and selected co-morbidities. PPCM incidence rate/10 000 live births per calendar year was calculated with the numerator representing the weighted number of women aged 15 to 54 years with PPCM in that calendar year, and the denominator representing the number of live births in women aged 15 to 54 years for the given subgroup in the same year. Statistical significance of temporal trends in PPCM incidence was assessed using negative binomial regression of the number of PPCM cases per year, offset by the log of number of live births in the given year.

The NIS database categorizes race/ethnicity as "White (Caucasian)," "Black (African-American)," "Hispanic," "Asian or Pacific Islander," "Native American," "other," or "unkonwn/missing." In our study cohort, 750 (2.2%) women were classified as having "other" race/ethnicity and 7318 (21.4%) as "unknown/missing" race/ethnicity. Due to the large proportion of "other/unknown/missing" race we used 2 approaches to calculate race/ethnicity-specific PPCM incidence rates. In the first approach we used only cases with complete information (complete case analysis) to calculate

race/ethnicity-specific PPCM incidence rates for the pre-specified subgroups (Caucasian, African-American, Hispanic, Asian/Pacific Islander, and Native American). Since it is not possible to determine which racial/ethnic groups are included in the "other" category in the NIS database and since there was no corresponding denominator in the CDC VitalStats birth data for this category, we did not calculate incidence rates for this subgroup. Next, we performed multiple imputation to impute missing values for race/ethnicity using the fully conditional specification (FCS) method (an iterative Markov Chain Monte Carlo algorithm) in SPSS 20.0 to create 5 complete data sets. The pooled values were then used to calculate race/ethnicity-specific PPCM incidence rates. For multiple imputation, both "other" and "unknown/missing" categories were considered as missing.

To evaluate temporal changes in baseline characteristics, we used the Mantel-Haenszel χ^2 test of linear association for categorical variables and linear regression for continuous variables. Next, we analyzed the temporal trends in primary and secondary outcomes in women with PPCM. To assess whether outcomes have improved over time, unadjusted and multivariable adjusted logistic regression models were constructed for the overall cohort. Our independent variable, calendar year, was initially entered as a continuous variable in the regression models to obtain unadjusted and adjusted odds ratios (per year) for the overall temporal trend in outcomes. To determine if there was a temporal variability from year-to-year in the outcomes, we also evaluated calendar year as a categorical variable, with 2004 as the reference year. The regression models adjusted for all demographics, hospital characteristics, and co-morbidities listed in Table 4.

Statistical analysis was performed using IBM SPSS Statistics 20.0 (IBM Corp). All P values were 2 sided with a significance threshold of $P<0.05$. Categorical variables are expressed as percentage and continuous variables as mean±standard deviation. OR and 95% CI are used to report the results of logistic regression.

Results

Overall Incidence and Baseline Characteristics of Patients With PPCM

Between 2004 and 2011, we identified 34 219 women aged 15 to 54 years with the diagnosis of PPCM. According to the CDC VitalStats, there were a total of 33 118 166 live births in women aged 15 to 54 years during this period. These data provide an overall PPCM rate of 10.3 (95% CI 10.2 to 10.4) per 10 000 live births (or 1 in 968 live births) (Table 2). The incidence of PPCM increased with age and was highest among women aged 40 to 54 years (36.7 [95% CI 35.4 to 37.9] per 10 000 live births). When stratified according to race/ethnicity, PPCM incidence was lowest in Hispanics and highest in African Americans (Table 3). The incidence of PPCM was lowest in the West (6.5 [95% CI 6.3 to 6.7] per 10 000 live births) and highest in the South (13.1 [95% CI 12.9 to 13.3] per 10 000 live births). When stratified according to the presence or absence of known risk factors for PPCM, women with chronic hypertension had the highest incidence of PPCM (267.5 [95% CI 262.3 to 272.7] per 10 000 live births). Similarly, the presence of eclampsia and diabetes mellitus were associated with a higher incidence of PPCM than their absence (Table 2). PPCM rates were similar in women with or without pregnancy-associated hypertension (10.1 [95% CI 9.5 to 10.6] and 10.4 [95% CI 10.3 to 10.5] per 10 000 live births, respectively). Interestingly, PPCM rates were higher in women who were non-smokers, primipara, or had single gestation pregnancy (Table 2).

Mean age of the overall cohort was 30.3±7.0 years with 85.5% of women in the 20 to 39-year age group (Table 4). African Americans (47.5%) constituted the highest proportion of patients with PPCM. The most common primary expected payer was Medicaid (48.1%), and 38.6% of patients had median household income in the first quartile. The South had the highest proportion of PPCM patients (48%). Most women with PPCM were hospitalized in large, urban, teaching hospitals. Most common co-morbidities in women with PPCM were anemia (30.5%), chronic hypertension (30.3%), fluid and electrolyte disorders (21.3%), obesity (13.9%), chronic pulmonary disease (11.6%), and preeclampsia (11.3%). Only 0.3% of all women with PPCM were multipara.

Temporal Trends in Incidence and Baseline Characteristics

In the overall cohort, PPCM incidence rate increased significantly from 8.5 per 10 000 live births (1 in 1181 live births) in 2004 to 11.8 per 10 000 live births (1 in 849 live births) in 2011 ($P_{trend}<0.001$) (Figure 1). A similar increase in PPCM rates were seen in women ≥20 years of age, in all racial/ethnic groups (except Hispanics and Asian/Pacific Islanders), and across all census regions in the United States during the study period ($P_{trend}<0.05$ for all) (Tables 2 and 3). From 2004 to 2011, there was a significant increase in the incidence of PPCM in patients with chronic hypertension (219.7 to 295.7 per 10 000 live births, $P_{trend}<0.001$) and diabetes mellitus (16.5 to 21.3 per 10 000 live births, $P_{trend}<0.001$), but not in those with pregnancy-associated hypertension or eclampsia (Table 2). As expected, based on current recommendations regarding avoidance of subsequent pregnancies after the development of PPCM, the rates of PPCM were higher among primipara women. Interestingly, women with multiple gestation pregnancies had a lower rate of PPCM (Table 2).

Table 2. Temporal Trends in Peripartum Cardiomyopathy Incidence Rate/10 000 Live Births

	n	Overall	2004	2005	2006	2007	2008	2009	2010	2011	P_{trend}
Overall	34 219	10.3	8.5	8.8	9.4	10.3	10.1	11.8	12.2	11.8	<0.001
Age, y											
15 to 19	1713	5.3	5.1	4.4	5.4	5.7	4.2	5.0	8.0	4.5	0.407
20 to 29	14 506	8.3	6.8	7.5	7.3	8.7	8.5	9.8	8.6	9.6	<0.001
30 to 39	14 683	12.7	10.2	10.5	11.9	12.4	12.2	14.7	16.2	13.9	<0.001
40 to 54	3316	36.7	31.4	29.0	35.2	33.8	37.8	37.4	43.0	45.1	<0.001
Census region											
Northeast	4964	9.3	8.0	6.5	6.7	9.4	9.8	10.8	14.0	9.3	0.002
Midwest	7478	10.7	8.1	9.1	9.3	11.1	9.9	14.4	11.7	11.8	<0.001
South	16 410	13.1	11.1	11.2	13.3	12.7	12.6	13.8	14.7	15.5	<0.001
West	5366	6.5	5.1	6.4	5.2	6.7	6.6	6.9	7.7	7.6	<0.001
Co-morbidities											
Chronic HTN											
Yes	10 380	267.5	219.7	215.6	228.4	281.4	273.3	315.6	283.2	295.7	<0.001
No	23 839	7.3	6.4	6.7	7.0	7.3	7.0	7.9	8.6	7.7	<0.001
Pregnancy-associated HTN											
Yes	1346	10.1	11.0	9.6	10.6	10.3	7.7	10.6	10.4	10.5	0.937
No	32 873	10.4	8.4	8.8	9.4	10.4	10.3	11.9	12.4	11.9	<0.001
Eclampsia											
Yes	501	59.6	63.0	56.7	45.3	32.5	65.1	109.1	39.6	64.9	0.574
No	33 719	12.0	9.7	9.8	10.5	11.7	12.2	14.0	14.8	14.3	<0.001
Diabetes mellitus											
Yes	2698	18.2	16.5	12.5	15.8	18.5	18.2	22.2	18.3	21.3	<0.001
No	31 521	10.0	8.2	8.7	9.1	10.0	9.8	11.3	12.0	11.3	<0.001
Tobacco use											
Yes	2722	14.5	10.2	17.7	20.0	13.3	11.5	18.0	16.0	11.2	0.830
No	31 496	18.2	13.0	15.7	18.4	23.1	20.2	22.3	19.4	16.0	0.185
Multiparity											
Yes	115	0.06	0.04	0.06	0.06	0.06	0.07	0.06	0.05	0.08	0.210
No	34 104	25.8	21.3	22.2	23.6	25.7	25.1	29.2	30.5	29.4	<0.001
Multiple gestation											
Yes	701	6.2	6.2	6.3	5.4	6.6	8.1	7.4	5.3	4.2	0.257
No	33 518	10.5	8.5	8.9	9.5	10.4	10.2	11.9	12.5	12.0	<0.001

"n" indicates the number of discharges across all years. The numbers are weighted to reflect PPCM cases in the entire United States population. HTN indicates hypertension.

In the overall cohort of patients with PPCM, mean age increased slightly from 30.1±7.0 in 2004 to 30.8±7.1 in 2011 (P_{trend}<0.001) with a decrease in the proportion of women aged 15 to 19 years and a concurrent increase in the proportion of women aged 40 to 54 years (Table 4). In patients with PPCM, the proportion of African-American women increased during the study period (Table 4). There was a significant increase in the prevalence of chronic hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, anemia, rheumatoid arthritis/collagen vascular diseases, chronic pulmonary disease, coagulopathy, depression, drug abuse, hypothyroidism, liver disease, fluid, and electrolyte disorder, paralysis, other neurological disorders, obesity, peripheral vascular disease, psychoses, pulmonary circulation disorders, and chronic kidney disease (P_{trend}<0.05 for all) in women with PPCM during the study period (Table 4). On the

Table 3. Temporal Trends in Peripartum Cardiomyopathy Incidence Rate/10 000 Live Births Stratified According to Race/Ethnicity

	n	Overall	2004	2005	2006	2007	2008	2009	2010	2011	P_{trend}
Complete case analysis											
Caucasian	11 561	6.4	5.2	5.8	5.3	5.8	6.4	7.2	8.3	7.6	<0.001
African–American	10 948	22.8	15.9	13.7	15.9	19.9	21.5	28.3	32.5	35.2	<0.001
Hispanic	2813	3.6	2.9	3.8	3.2	3.6	3.3	3.4	4.3	3.9	<0.001
Asian/Pacific Islander	664	3.6	3.6	2.9	2.6	3.3	2.9	4.5	5.5	3.1	0.156
Native American	165	5.0	0.0	1.2	5.9	4.4	5.0	5.8	6.0	12.0	0.001
Other	750	—	—	—	—	—	—	—	—	—	—
Unknown/missing	7318	—	—	—	—	—	—	—	—	—	—
Multiple imputation											
Caucasian	15 410	8.6	7.6	8.2	8.1	8.6	8.5	9.3	9.5	8.7	<0.001
African–American	14 109	29.4	21.1	20.0	24.8	28.2	29.1	36.5	36.7	39.0	<0.001
Hispanic	3500	4.4	4.1	4.9	4.5	4.8	4.0	4.1	4.8	4.1	0.423
Asian/Pacific Islander	901	4.8	5.3	4.4	4.3	5.3	3.7	5.4	7.0	3.4	0.912
Native American	299	9.1	3.4	3.2	9.0	10.5	10.9	10.1	11.7	14.2	<0.001

"n" indicates the number of discharges across all years. The numbers are weighted to reflect PPCM cases in the entire United States population. Both "other" and "unknown/missing" race categories were considered as missing for multiple imputation.

other hand, the prevalence of tobacco use, pregnancy-associated hypertension, pre-eclampsia, and multiple gestations decreased significantly (P_{trend}<0.05 for all) during the past 8 years. The prevalence of eclampsia remained unchanged during the study period (P_{trend}=0.127).

Trends in Outcomes in Women With PPCM

Our primary outcome of interest was maternal MAE. In the overall cohort, MAE occurred in 4633 (13.5%) patients. The observed MAE rate was 11.7% in 2004 and 15.1% in 2011. However, when adjusted for demographics, hospital characteristics, and co-morbidities, no significant temporal trend was noted for this observed rise in MAE (adjusted OR [per year] 0.99, 95% CI 0.98 to 1.01, P_{trend}=0.277) (Table 5).

Table 6 shows the overall rates and temporal trends in secondary outcomes. In-hospital mortality occurred in 435 (1.3%) women in the overall cohort. There was a statistically significant increase in in-hospital mortality from 0.7% in 2004 to 1.8% in 2011 (P_{trend}<0.001), which persisted even after adjusting for possible confounding variables (adjusted OR [per year] 1.08, 95% CI 1.02 to 1.14, P_{trend}=0.006) (Table 6). The most common complication in women with PPCM was thromboembolism (6.6%). The incidence of other complications was: cardiac arrest in 2.1%, heart transplant in 0.5%, mechanical circulatory support in 1.5%, acute pulmonary edema in 1.8%, ICD/PPM placement in 2.9%, and cardiogenic shock in 2.6% (Table 6). No significant upward or downward trend was noted for most of these complications, except an increase in cardiogenic shock from 1.0% in 2004 to 4.0% in 2011 (adjusted OR [per year] 1.16, 95% CI 1.11 to 1.21, P_{trend}<0.001), and mechanical circulatory support from 0.9% in 2004 to 2.2% in 2011 (adjusted OR [per year] 1.08, 95% CI 1.03 to 1.14, P_{trend}=0.002) (Table 6). The median length of stay for the overall cohort was 3 days (interquartile range 2 to 6 days). The proportion of patients with length of stay >3 days decreased from 52.5% in 2004 to 49.1% in 2011 (adjusted OR [per year] 0.95, 95% CI 0.94 to 0.96, P_{trend}=0.006) (Table 6).

Discussion

In this study, we report the overall incidence rate as well as the temporal trends in incidence and outcomes of PPCM using a contemporary, real-world, nationwide, all-payer database of hospitalized patients in the United States. To our knowledge, this is the largest cohort of PPCM patients described to date. The major findings of our study are: (1) the overall PPCM rate during 2004-2011 was 10.3 per 10 000 live births (1 in 968 live births); (2) PPCM incidence rate increased from 8.5 per 10 000 live births (1 in 1181 live births) in 2004 to 11.8 per 10 000 live births (1 in 849 live births) in 2011; (3) the temporal increase in PPCM incidence rates was seen in all women ≥20 years of age, in all racial/ethnic groups (except Hispanics and Asian/Pacific Islanders), and across all census regions in the United States; (4) the

Table 4. Baseline Demographics, Hospital Characteristics and Co-Morbidities of Patients With Peripartum Cardiomyopathy

Variable	Overall	2004	2005	2006	2007	2008	2009	2010	2011	P_{trend}
No. of cases (weighted)	34 219	3475	3635	3998	4442	4281	4850	4886	4652	—
Age, y	30.3±7.0	30.1±7.0	29.9±7.0	30.3±7.1	29.9±7.0	30.2±7.1	30.4±6.8	30.6±7.1	30.8±7.1	<0.001
15 to 19	5.0%	6.1%	5.0%	5.9%	5.7%	4.3%	4.2%	6.0%	3.2%	
20 to 29	42.4%	41.6%	44.6%	41.2%	45.0%	44.5%	43.9%	36.7%	42.3%	
30 to 39	42.9%	42.3%	41.6%	43.0%	40.8%	41.1%	43.2%	47.2%	43.2%	
40 to 54	9.7%	9.9%	8.9%	9.9%	8.6%	10.0%	8.8%	10.1%	11.3%	
Race										<0.001
Caucasian	33.8%	34.3%	36.5%	30.7%	30.0%	33.8%	33.0%	36.7%	35.2%	
African–American	32.0%	26.3%	22.0%	24.4%	27.9%	31.2%	35.5%	39.2%	44.0%	
Hispanic	8.2%	7.9%	10.3%	8.3%	8.6%	8.1%	7.1%	8.2%	7.7%	
Asian/Pacific Islander	1.9%	2.3%	1.8%	1.5%	1.8%	1.6%	2.2%	2.7%	1.6%	
Native American	0.5%	0.0%	0.1%	0.6%	0.4%	0.5%	0.5%	0.5%	1.0%	
Other	2.2%	2.7%	1.3%	1.4%	1.9%	1.4%	2.5%	3.1%	3.0%	
Unknown/missing	21.4%	26.4%	28.1%	33.1%	29.3%	23.3%	19.2%	9.7%	7.5%	
Primary expected payer										<0.001
Medicare	6.4%	8.3%	3.6%	5.6%	5.0%	5.7%	6.5%	6.5%	9.4%	
Medicaid	48.1%	43.6%	46.8%	46.9%	48.9%	48.0%	49.5%	51.3%	48.0%	
Private insurance	38.4%	43.4%	42.4%	38.9%	37.9%	38.1%	37.7%	35.5%	35.3%	
Uninsured	4.1%	2.8%	4.0%	5.0%	4.7%	4.0%	3.7%	4.5%	3.9%	
Other	3.1%	1.9%	3.3%	3.7%	3.4%	4.1%	2.5%	2.2%	3.4%	
Median household income										<0.001
0 to 25th percentile	38.6%	36.1%	33.7%	37.8%	39.1%	38.9%	37.3%	43.1%	40.7%	
26th to 50th percentile	24.1%	23.8%	23.7%	25.6%	24.0%	26.4%	26.1%	21.0%	22.8%	
51st to 75th percentile	21.7%	21.0%	25.5%	21.1%	21.8%	20.9%	21.4%	20.6%	22.2%	
76th to 100th percentile	15.5%	19.2%	17.1%	15.5%	15.2%	13.8%	15.2%	15.3%	14.2%	
Weekend admission	22.6%	22.2%	23.9%	21.8%	22.2%	22.3%	22.0%	21.1%	25.5%	0.153
Hospital characteristics										
Region										0.001
Northeast	14.5%	15.7%	12.0%	11.4%	14.5%	15.4%	14.7%	18.6%	12.9%	
Midwest	21.9%	20.8%	22.2%	21.1%	22.5%	20.7%	25.8%	20.1%	21.2%	
South	48.0%	48.6%	47.5%	53.6%	46.7%	47.5%	45.0%	45.7%	50.1%	
West	15.7%	14.9%	18.2%	13.9%	16.3%	16.4%	14.5%	15.6%	15.8%	
Bed size										<0.001
Small	7.2%	8.4%	8.5%	8.2%	8.1%	6.6%	6.5%	4.5%	7.5%	
Medium	22.5%	22.7%	25.5%	24.7%	25.3%	23.4%	19.0%	21.7%	18.6%	
Large	70.4%	68.9%	66.0%	67.1%	66.6%	70.0%	74.5%	73.8%	73.9%	
Urban location	92.3%	92.0%	89.8%	91.7%	92.0%	92.5%	93.8%	90.9%	94.8%	<0.001
Teaching hospital	60.1%	58.1%	50.7%	58.5%	58.6%	62.8%	65.0%	58.9%	65.7%	<0.001
Co-morbidities										
Chronic HTN	30.3%	24.9%	25.3%	26.3%	29.9%	32.0%	33.9%	31.3%	35.9%	<0.001
Diabetes mellitus	7.9%	7.0%	5.5%	7.1%	8.0%	8.2%	9.0%	7.6%	9.9%	<0.001

Continued

Table 4. Continued

Variable	Overall	2004	2005	2006	2007	2008	2009	2010	2011	P_{trend}
Tobacco use	8.0%	8.2%	11.9%	10.7%	6.3%	5.8%	7.7%	7.7%	6.4%	<0.001
Dyslipidemia	4.3%	3.4%	2.4%	3.3%	3.5%	4.5%	5.6%	5.3%	5.8%	<0.001
Atrial fibrillation	2.2%	1.6%	1.9%	1.5%	1.7%	1.6%	3.1%	2.7%	3.1%	<0.001
Alcohol abuse	0.8%	0.4%	0.6%	0.8%	1.1%	1.0%	0.8%	0.3%	1.2%	0.080
Anemia	30.5%	26.2%	31.7%	27.6%	27.9%	28.1%	33.0%	33.9%	34.0%	<0.001
RA/collagen vascular diseases	1.3%	1.2%	1.0%	0.9%	0.8%	1.5%	1.9%	1.5%	1.6%	<0.001
Chronic pulmonary disease	11.6%	9.1%	10.7%	10.0%	10.5%	13.3%	11.2%	11.8%	15.2%	<0.001
Coagulopathy	3.5%	2.3%	3.1%	1.8%	4.6%	3.0%	3.9%	4.0%	4.3%	<0.001
Depression	6.6%	5.4%	5.4%	6.5%	7.2%	6.6%	6.2%	7.1%	7.5%	<0.001
Drug abuse	4.4%	3.6%	2.4%	4.5%	4.7%	3.9%	4.5%	4.9%	5.9%	<0.001
Hypothyroidism	3.5%	1.7%	1.8%	3.7%	2.6%	4.9%	3.3%	4.1%	5.5%	<0.001
Liver disease	0.6%	0.3%	0.3%	0.6%	0.6%	0.4%	0.6%	0.8%	0.8%	<0.001
Malignancy	0.3%	0.3%	0.6%	0.2%	0.1%	0.4%	0.4%	0.1%	0.3%	0.180
Fluid and electrolyte disorder	21.3%	18.9%	18.3%	18.3%	20.8%	20.0%	24.3%	22.7%	25.2%	<0.001
Other neurological disorders	2.2%	1.7%	2.5%	1.9%	1.6%	1.6%	2.8%	2.6%	2.8%	<0.001
Obesity	13.9%	10.6%	9.2%	10.2%	13.8%	13.9%	15.1%	14.8%	21.1%	<0.001
Paralysis	0.6%	0.3%	0.4%	0.6%	0.4%	0.8%	1.4%	0.3%	0.6%	0.009
Peripheral vascular disease	0.4%	0.3%	0.1%	0.2%	0.2%	0.8%	0.4%	0.1%	0.7%	0.001
Psychoses	2.5%	1.5%	2.4%	1.7%	1.9%	3.5%	3.0%	2.4%	3.5%	<0.001
Pulmonary circulation disorders	5.8%	3.8%	3.6%	5.3%	5.3%	5.4%	6.2%	7.0%	8.3%	<0.001
Chronic kidney disease	3.3%	0.5%	1.3%	3.0%	3.6%	3.9%	4.5%	3.4%	4.9%	<0.001
Pregnancy-associated HTN	3.9%	4.9%	4.3%	4.4%	3.9%	3.0%	3.7%	3.7%	3.9%	0.002
Pre-eclampsia	11.3%	11.8%	12.4%	11.1%	12.4%	12.1%	9.9%	12.3%	8.9%	<0.001
Eclampsia	1.5%	2.0%	1.7%	1.2%	0.8%	1.5%	2.5%	0.9%	1.3%	0.127
Antepartum hemorrhage	1.0%	0.6%	1.1%	1.2%	1.3%	1.1%	0.7%	0.9%	0.9%	0.747
Multiparity	0.3%	0.3%	0.4%	0.4%	0.3%	0.4%	0.3%	0.2%	0.4%	0.905
Multiple gestation	2.0%	2.5%	2.4%	1.9%	2.2%	2.7%	2.2%	1.5%	1.2%	<0.001

Data are expressed as mean±standard deviation for continuous variables and number (percentage) for categorical variables. Numbers indicate weighted results. HTN indicates hypertension; RA, rheumatoid arthritis.

overall frequency of maternal MAE was 13.5% and remained stable during the study period; (5) in-hospital mortality in women with PPCM was 1.3% and increased slightly during the past 8 years; and (6) the most common complication in women with PPCM was thromboembolism (6.6%).

PPCM is an idiopathic dilated cardiomyopathy that presents in women during the latter part of pregnancy or the first several months after delivery. Prior studies have reported the incidence of PPCM in the United States to be between 1 in 1141 to 1 in 4350 live births (mean 1 in 3186 live births).[4–8] Mielniczuk et al analyzed data on 16 296 PPCM cases among 3.6 million patient discharges included in the 1990-2002 National Hospital Discharge Survey (NHDS) and reported an overall PPCM incidence of 1 in 3189 live births.[5] There was a non-significant trend for an increase in PPCM incidence over time, from 1 in 4350 live births in 1990-1993 to 1 in 2229 live births in 2000-2002. Despite changes in coding for PPCM, our current results from the 2004 to

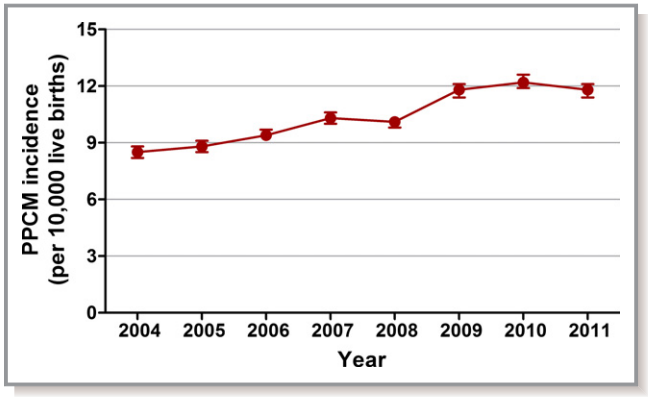

Figure. 1. Temporal trends in peripartum cardiomyopathy incidence rate/10 000 live births. PPCM incidence rate/10 000 live births per calendar year was calculated with the numerator representing the number of women aged 15 to 54 years with PPCM in that calendar year, and the denominator representing the number of live births in women aged 15 to 54 years for in the same calendar year. $P_{trend}<0.001$. Error bars represent 95% confidence interval (CI).

2011 NIS databases are consistent with, and extend these prior findings from the NHDS. In the present study, PPCM incidence rate increased significantly from 1 in 1181 live births in 2004 to 1 in 849 live births in 2011. Compared with prior reports, the higher incidence of PPCM in the present study could be due to differences in case selection (clinical data versus ICD-9-CM codes, delivering only versus all PPCM), time period under consideration, and more selective (single center/region) versus nationally representative population.

There are several potential explanations for the observed increase in PPCM incidence over the past 8 years. First, it is possible that the actual incidence of PPCM has increased over time, which may be related to increasing maternal age, and increasing prevalence of established risk factors for PPCM (eg, chronic hypertension, preeclampsia/eclampsia, and multiple births), as well as other cardiovascular co-morbidities (eg, obesity and diabetes mellitus) in pregnant women.[14–17] Similar to previous studies, we observed a higher incidence of PPCM in women with known risk factors such as chronic hypertension, eclampsia, and diabetes mellitus. We also found an increasing trend in several cardiovascular risk factors in women with PPCM (Table 4). Second, the increase in incidence could be attributable to expansion of the definition of PPCM to extend the time frame during which this condition may occur or be diagnosed.[2] Third, our data may also be explained, at least in part, by increasing recognition and diagnosis of PPCM. Lastly, differences in case finding/coding during the study period cannot be completely eliminated.

In our study, maternal MAE occurred in 13.5% of women with PPCM. There was no significant change in MAE rate during the study period. In a retrospective review and analysis of clinical data of 182 patients with PPCM, Goland et al reported MAE in 25% of patients over a 6-year follow-up, with 84% of MAE occurring during the first year.[9] Kao et al recently reported in-hospital outcomes in 535 delivering women with PPCM from 6 states. Maternal MAE (defined as in-hospital death, cardiac arrest, heart transplant, or mechanical circulatory support) occurred in 6.7% of women with PPCM.[10] These differences in the observed rates of MAE are likely due to differences in patient selection criteria (clinical data versus ICD-9-CM codes, delivering only versus all PPCM), definition of MAE as well as individual outcomes, and the follow-up period.[4–8]

Reported mortality rates for PPCM in the United States have varied widely with lower rates observed in more recent studies.[18] Brar et al concluded that mortality rates associated with PPCM were lower than initially reported at 2.5% over a mean follow-up of 4.7 years, and Goland et al reported a mortality rate of 7% over an 8-year follow-up.[6,9] Because the hospital records are de-identified, the NIS does not contain post-discharge data on long-term mortality. Therefore, in the present study, we were able to determine only the in-hospital mortality rate, which was 1.3% in the overall cohort and showed a small but statistically significant increase over the past 8 years. Our results are consistent with the previously reported in-hospital mortality rate of 1.36% to 2.05% in the NHDS.[5] Felker et al, in a retrospective review of cardiomyopathies of various etiologies, reported markedly lower mortality in PPCM compared with idiopathic and other forms of cardiomyopathies.[19] Compared with an overall in-hospital mortality rate of 1.3% in PPCM patients in the present study,

Table 5. Temporal Trend in Primary Outcome (Major Adverse Events) in Patients With Peripartum Cardiomyopathy

MAE	Overall	2004	2005	2006	2007	2008	2009	2010	2011	Odds Ratio Per Year*
%	13.5	11.7	14.0	12.5	11.6	14.9	15.4	12.6	15.1	—
Unadjusted OR	—	Ref.	1.23 (1.07 to 1.41)	1.08 (0.94 to 1.24)	1.00 (0.87 to 1.14)	1.32 (1.16 to 1.51)	1.38 (1.21 to 1.57)	1.09 (0.95 to 1.24)	1.35 (1.18 to 1.54)	1.03 (1.02 to 1.05)
Adjusted OR	—	Ref.	1.01 (0.86 to 1.20)	0.89 (0.75 to 1.06)	0.81 (0.69 to 0.95)	1.06 (0.91 to 1.24)	0.94 (0.80 to 1.09)	0.82 (0.70 to 0.95)	0.97 (0.83 to 1.12)	0.99 (0.98 to 1.01)

Percentages indicate weighted results. Numbers in parenthesis represent 95% confidence interval (CI). MAE indicates major adverse events; OR, odds ratio.
*Unadjusted and adjusted odds ratios per year and *P* values for trend were determined using logistic regression models evaluating calendar year as a continuous variable.

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Table 6. Temporal Trends in Secondary Outcomes in Patients With Peripartum Cardiomyopathy

Outcome	Overall	2004	2005	2006	2007	2008	2009	2010	2011	Odds Ratio Per Year*
In-hospital mortality										
%	1.3	0.7	1.3	0.4	1.6	0.6	1.8	1.6	1.8	—
Unadjusted OR	—	Ref.	1.86 (1.15 to 3.01)	0.48 (0.25 to 0.93)	2.13 (1.35 to 3.37)	0.79 (0.45 to 1.37)	2.49 (1.60 to 3.87)	2.20 (1.41 to 3.45)	2.25 (1.61 to 3.92)	1.13 (1.08 to 1.18)
Adjusted OR	—	Ref.	1.08 (0.62 to 1.88)	0.14 (0.05 to 0.39)	1.50 (0.91 to 2.49)	0.64 (0.35 to 1.17)	0.97 (0.58 to 1.62)	1.37 (0.83 to 2.24)	1.39 (0.86 to 2.24)	*1.08 (1.02 to 1.14)*
Cardiac arrest										
%	2.1	1.9	2.1	0.5	2.2	3.2	2.3	1.7	2.6	—
Unadjusted OR	—	Ref.	1.09 (0.78 to 1.52)	0.24 (0.14 to 0.40)	1.18 (0.86 to 1.62)	1.71 (1.27 to 2.30)	1.21 (0.89 to 1.64)	0.89 (0.64 to 1.23)	1.40 (1.04 to 1.90)	1.06 (1.02 to 1.10)
Adjusted OR	—	Ref.	0.79 (0.54 to 1.15)	0.23 (0.14 to 0.40)	0.88 (0.62 to 1.25)	1.35 (0.97 to 1.87)	0.57 (0.40 to 0.83)	0.62 (0.43 to 0.87)	0.97 (0.70 to 1.35)	1.00 (0.97 to 1.04)
Heart transplant										
%	0.5	0.5	0.3	0.3	0.3	0.9	0.6	0.4	0.5	—
Unadjusted OR	—	Ref.	0.53 (0.24 to 1.14)	0.46 (0.21 to 1.00)	0.62 (0.31 to 1.24)	1.74 (0.99 to 3.04)	1.14 (0.63 to 2.05)	0.82 (0.44 to 1.54)	0.95 (0.51 to 1.76)	1.06 (0.99 to 1.13)
Adjusted OR	—	Ref.	0.22 (0.05 to 0.98)	0.22 (0.05 to 0.98)	0.30 (0.10 to 0.89)	2.78 (1.25 to 6.16)	0.58 (0.23 to 1.44)	0.88 (0.37 to 2.08)	0.79 (0.35 to 1.81)	1.06 (0.96 to 1.18)
Mechanical circulatory support										
%	1.5	0.9	0.8	0.6	1.5	1.4	2.1	1.6	2.2	—
Unadjusted OR	—	Ref.	0.87 (0.53 to 1.44)	0.65 (0.38 to 1.10)	1.65 (1.08 to 2.51)	1.53 (1.00 to 2.35)	2.33 (1.56 to 3.46)	1.70 (1.12 to 2.56)	2.43 (1.64 to 3.62)	1.17 (1.12 to 1.21)
Adjusted OR	—	Ref.	0.64 (0.35 to 1.19)	0.66 (0.36 to 1.23)	1.34 (0.82 to 2.20)	1.25 (0.76 to 2.07)	1.15 (0.71 to 1.84)	0.99 (0.61 to 1.60)	1.65 (1.05 to 2.59)	*1.08 (1.03 to 1.14)*
Acute pulmonary edema										
%	1.8	1.3	2.2	1.5	1.5	1.9	2.0	2.3	1.5	—
Unadjusted OR	—	Ref.	1.72 (1.18 to 2.49)	1.15 (0.78 to 1.70)	1.21 (0.83 to 1.77)	1.46 (1.01 to 2.12)	1.53 (1.07 to 2.20)	1.82 (1.28 to 2.58)	1.17 (0.80 to 1.71)	1.03 (0.99 to 1.07)
Adjusted OR	—	Ref.	1.59 (1.02 to 2.46)	0.89 (0.54 to 1.46)	1.19 (0.77 to 1.85)	1.41 (0.92 to 2.17)	1.54 (1.02 to 2.34)	1.94 (1.30 to 2.89)	0.92 (0.58 to 1.45)	1.03 (0.99 to 1.08)

Continued

Table 6. Continued

Outcome	Overall	2004	2005	2006	2007	2008	2009	2010	2011	Odds Ratio Per Year*
Thromboembolism										
%	6.6	5.6	6.8	7.7	5.2	5.7	8.3	5.7	7.9	—
Unadjusted OR	—	Ref.	1.22 (1.00 to 1.48)	1.39 (1.15 to 1.67)	0.93 (0.76 to 1.13)	1.02 (0.84 to 1.24)	1.51 (1.27 to 1.80)	1.01 (0.84 to 1.22)	1.43 (1.19 to 1.71)	1.03 (1.01 to 1.05)
Adjusted OR	—	Ref.	0.93 (0.74 to 1.16)	1.03 (0.83 to 1.29)	0.75 (0.59 to 0.94)	0.78 (0.63 to 0.98)	1.06 (0.87 to 1.30)	0.72 (0.58 to 0.89)	0.99 (0.81 to 1.20)	0.99 (0.97 to 1.01)
AICD/PPM										
%	2.9	2.6	2.7	2.5	2.2	4.5	2.6	2.5	3.7	—
Unadjusted OR	—	Ref.	1.01 (0.76 to 1.35)	0.94 (0.71 to 1.25)	0.84 (0.63 to 1.12)	1.73 (1.34 to 2.23)	0.96 (0.73 to 1.27)	0.93 (0.71 to 1.23)	1.40 (1.09 to 1.82)	1.04 (1.01 to 1.07)
Adjusted OR	—	Ref.	1.09 (0.78 to 1.54)	1.12 (0.80 to 1.56)	0.86 (0.62 to 1.21)	1.51 (1.12 to 2.05)	0.83 (0.60 to 1.14)	0.76 (0.55 to 1.04)	1.20 (0.89 to 1.61)	0.99 (0.96 to 1.03)
Cardiogenic shock										
%	2.6	1.0	1.9	1.7	2.4	1.9	3.8	3.1	4.0	—
Unadjusted OR	—	Ref.	2.00 (1.32 to 3.03)	1.80 (1.19 to 2.72)	2.50 (1.69 to 3.70)	2.01 (1.35 to 3.02)	4.06 (2.80 to 5.88)	3.31 (2.27 to 4.82)	4.30 (2.97 to 6.22)	1.18 (1.14 to 1.22)
Adjusted OR	—	Ref.	1.47 (0.90 to 2.41)	1.01 (0.60 to 1.72)	2.34 (1.50 to 3.66)	1.53 (0.96 to 2.44)	2.10 (1.37 to 3.21)	2.24 (1.47 to 3.42)	3.28 (2.17 to 4.96)	*1.16 (1.11 to 1.21)*
LOS>3 days										
%	49.7	52.5	51.6	53.5	50.6	46.3	48.2	47.1	49.1	—
Unadjusted OR	—	Ref.	0.97 (0.98 to 1.06)	1.04 (0.95 to 1.14)	0.93 (0.85 to 1.01)	0.78 (0.71 to 0.85)	0.84 (0.77 to 0.92)	0.81 (0.74 to 0.88)	0.88 (0.80 to 0.96)	0.97 (0.96 to 0.98)
Adjusted OR	—	Ref.	0.87 (0.77 to 0.97)	0.93 (0.83 to 1.04)	0.82 (0.73 to 0.92)	0.63 (0.56 to 0.70)	0.68 (0.61 to 0.75)	0.65 (0.58 to 0.72)	0.72 (0.65 to 0.80)	*0.95 (0.94 to 0.96)*

Numbers in parenthesis represent 95% confidence interval
(CI). LOS indicates length of stay; OR, odds ratio; PPM, permanent pacemaker.
*Unadjusted and adjusted odds ratios per year and *P* values for trend were determined using logistic regression models evaluating calendar year as a continuous variable. Adjusted OR per year shown in italics indicate statistically significant temporal trend
(P_{trend}<0.05).

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in-hospital mortality rate in all HF patients (not including PPCM) was significantly higher at 3.8% in a recent analysis of the 2001-2009 NIS databases, suggesting that mortality is lower in PPCM as compared with other causes of HF.[20]

The most common complication in PPCM patients was thromboembolism (6.6%). There was no significant change in the rates of most complications, except for cardiogenic shock, which increased from 1.0% in 2004 to 4.0% in 2011. The increase in cardiogenic shock could be explained, at least partially, by early recognition and increasing diagnosis of this condition as well as changes in coding over the years. Alternatively, this may represent a true increase in cardiogenic shock since there was a parallel increase seen in the utilization of mechanical circulatory support during the study period. Recent data from the Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) registry showed that women with PPCM who receive mechanical circulatory support have a better survival than women with non-PPCM, with a 2-year survival of 83% and a recovery rate of 6% in PPCM group.[21] Reported rates of cardiac transplantation in women with PPCM in the United States have ranged from 0% to 11%.[2] The low rates of heart transplantation (0.5%) seen in our study are likely due to lack of availability of data on long-term follow-up. Dedicated registries such as the European Society of Cardiology EURObservational Registry on PPCM with systematic, prospective data collection are needed to confirm the incidence as well as to determine the long-term outcomes of PPCM.[22]

Study Limitations

Our study has limitations inherent to retrospective studies using administrative data. It is possible that we may have overestimated the incidence of PPCM due to the following reasons. First, due to the de-identified nature of the NIS database, we were unable to identify the number of unique admissions (ie, if the same patient was re-admitted more than once during the same pregnancy). Similarly some women might have had more than one pregnancy. However, because healthcare providers often discourage subsequent pregnancies in PPCM patients due to concerns of recurrent/persistent cardiac dysfunction and poorer outcomes including mortality, and because only 0.3% of women in our cohort were multipara, multiple pregnancies in the same patient likely had a small effect on the PPCM incidence rates.[3,23–25] Second, whereas conditions such as chronic hypertension, pre-eclampsia, diabetes mellitus, or anemia are established risk factors for PPCM, these conditions can themselves cause HF, especially during the postpartum period. Individual patient charts/records and echocardiographic measurements were not available to verify the accuracy of the ICD-9-CM codes used to identify women with PPCM and to definitely exclude other causes of HF.[5–7] The current PPCM ICD-9-CM codes introduced in 2003, although more specific than coding used in previous studies using administrative data, have not been validated systematically. Nonetheless, these ICD-9-CM codes have been used previously by other investigators to accurately identify patients with PPCM in administrative databases.[10] Another limitation is the unavailability of race/ethnicity data in all patients. Other limitations include lack of clinical information (eg, vital signs, medications, laboratory results), which is available in clinical trials or registries. Some of these limitations may be partially counterbalanced by the large sample size and absence of reporting bias due to selective participation of specialized centers in trials and/or registries. Lastly, the NIS does not contain post-discharge data on long-term outcomes.

Conclusion

This analysis of the 2004-2011 NIS databases describes the temporal trends in incidence and outcomes of PPCM in the United States. We find an increase in the incidence of PPCM over the past 8 years in the overall cohort, as well as in all women ≥20 years of age, in all racial/ethnic groups (except Hispanics and Asian/Pacific Islanders), and across all census regions in the United States. The overall MAE rate was 13.5% and remained stable during the study period. In-hospital mortality in women with PPCM was 1.3% and increased only slightly during the study period. The frequency of most complications remained unchanged, except an increase in cardiogenic shock and use of mechanical circulatory support. Mean length of stay decreased over the past 8 years. Further study of the mechanisms underlying these adverse trends in the incidence and outcomes of PPCM are warranted. Strategies to reduce the incidence and improve outcomes of PPCM should focus on controlling obesity, hypertension, diabetes mellitus, and promoting lifestyle modifications in women of childbearing age group.

Disclosures

None.

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