

A retrospective study of mode of delivery in patients with hypertrophic vs other forms of cardiomyopathy



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BACKGROUND: A better understanding of optimal modes of delivery is important for guiding peripartum recommendations for patients with cardiomyopathy and may differ by cardiomyopathy type.

OBJECTIVE: This study examines the association between mode of delivery and maternal morbidity events in patients with different types of cardiomyopathy: hypertrophic, dilated, peripartum, and other or unspecified.

STUDY DESIGN: This retrospective cohort study used the Premier Healthcare inpatient database, including patients aged 12 to 55 years who gave delivered after 25 weeks' gestation with a diagnosis of cardiomyopathy between 2016 and 2020. Patients were categorized into hypertrophic, dilated, peripartum, or other or unspecified cardiomyopathy subtypes based on International Classification of Diseases, Tenth edition codes. Mode of delivery was classified as vaginal or cesarean. Cesarean delivery was further classified as planned or intrapartum cesarean delivery. The exposure was the intended mode of delivery to simulate real-life delivery planning decisions (vaginal delivery, both completed and intrapartum cesarean delivery, vs planned cesarean delivery). An analysis by actual mode of delivery was also performed (completed vaginal deliveries vs intrapartum cesarean delivery and planned cesarean delivery). Outcomes included severe maternal morbidity, blood transfusion, 90-day readmission, and inotrope use. Each outcome was analyzed by cardiomyopathy subtype. Statistical analyses included descriptive comparisons and multivariable logistic regression, adjusting for age, insurance type, and comorbidities.

RESULTS: There were 1872 deliveries across all cardiomyopathy subtypes. Among the subtypes, the peripartum cardiomyopathy group displayed the highest rates of intrapartum cesarean delivery (34%) and severe maternal morbidity (32%), and the hypertrophic cardiomyopathy group displayed the lowest rates (20% and 7%, respectively). There were no significant differences in severe maternal morbidity among patients

with dilated (odds ratio, 1.50 [0.68–3.27]), peripartum (odds ratio, 1.32 [0.87–2.03]), or other (odds ratio, 0.80 [0.51–1.24]) cardiomyopathy when comparing intended cesarean vs intended vaginal delivery. In contrast, in the hypertrophic cardiomyopathy group, the odds ratio was 3.73 [1.56–13.57] for severe maternal morbidity when comparing intended cesarean vs intended vaginal delivery. In the analysis by actual mode of delivery, all cardiomyopathy subgroups had greater odds of severe maternal morbidity in cesarean vs vaginal delivery: hypertrophic (odds ratio, 3.98 [1.06–14.91]), dilated (odds ratio, 4.05 [1.64–10.00]), peripartum (odds ratio, 2.47 [1.50–4.07]), and other (odds ratio, 2.18 [1.36–3.51]). Among patients who delivered via cesarean delivery, the odds of severe maternal morbidity were higher across all subgroups, and rates of severe maternal morbidity events among the group requiring intrapartum conversion to cesarean delivery were high, suggesting this population to be at the highest risk.

CONCLUSION: Among patients with hypertrophic cardiomyopathy, a trial of labor was associated with lower morbidity compared with a planned cesarean delivery, implying either that more morbid patients were selected for cesarean or that cesarean delivery was uniquely less optimal than vaginal delivery for hypertrophic cardiomyopathy patients in comparison to other cardiomyopathies in this cohort. Although a trial of labor is the recommended mode of delivery for most patients with cardiomyopathy, patients at greatest risk are those who require intrapartum conversion to cesarean. Prospective studies are needed to determine the safe length of time in labor in these patients and the factors leading to unplanned cesarean delivery.

Key Words: cardiomyopathy, cardio-obstetrics, dilated cardiomyopathy, hypertrophic cardiomyopathy, inotrope, mode of delivery, peripartum cardiomyopathy

Introduction

The diagnosis of cardiomyopathy encompasses diverse etiologies with markedly different physiologic and hemodynamic profiles, each of which requires tailored peripartum management and

special considerations when determining the mode of delivery.^{1–4} For example, although preexisting cardiomyopathy in pregnancy is uncommon, affecting 76.1 (95% confidence interval [CI], 73.6–78.7) cases per 100,000 delivery hospitalizations, it is associated with a 2-fold increase in perinatal mortality compared with peripartum cardiomyopathy.⁵

Further, in comparison with patients with dilated cardiomyopathies, those with hypertrophic cardiomyopathy generally tolerate the increased blood volume of pregnancy well, though they remain at some risk for heart failure, arrhythmias, and syncope.^{6,7} Debate

persists regarding the safest mode of delivery in patients with hypertrophic cardiomyopathy because of concerns about hemodynamic sensitivity with changes in preload and the hemodynamic effects of the Valsalva maneuver during vaginal delivery. Compared with patients with hypertrophic cardiomyopathy, who may benefit from fluid resuscitation and typically do not require inotropic medications, patients with heart failure with a reduced ejection fraction, including those with dilated or peripartum cardiomyopathy, frequently require fluid restriction, diuresis, or inotropic medications.³

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AJOG MFM at a Glance

Why was this study conducted?

To examine how types of cardiomyopathy with distinct hemodynamic challenges affect maternal outcomes based on the mode of delivery.

Key findings

Among patients with hypertrophic cardiomyopathy, a trial of labor was associated with lower morbidity than a planned cesarean delivery. Among patients with dilated, peripartum, or other cardiomyopathy, cesarean delivery was associated with higher odds of inotrope use.

What does this add to what is known?

Among pregnant patients with hypertrophic, dilated, or peripartum cardiomyopathy, a trial of labor does not significantly increase the risk of maternal morbidity, blood transfusion, or hospital readmission compared with cesarean delivery. However, patients who delivered by unscheduled cesarean delivery had higher odds of morbidity compared with vaginal delivery or planned cesarean delivery.

A better understanding of optimal modes of delivery (ie, vaginal vs cesarean) is important to guide peripartum recommendations for patients with different etiologies of cardiomyopathy. Compared with vaginal deliveries, cesarean deliveries pose greater hemodynamic stress and increased risks of bleeding, thrombosis, embolism, and infection.^{1,2} However, patients with heart failure with reduced ejection fraction (HFrEF) may be unable to sufficiently augment cardiac output in response to the physiological demands of pregnancy and labor, leading to an increased risk of symptomatic heart failure and arrhythmias.^{3,8–10} Expert consensus suggests that a trial of labor is preferred for most patients with stable HFrEF (dilated and peripartum), reserving cesarean delivery for those with hemodynamic instability, severe obstruction, or obstetrical indications.² In a recent retrospective cohort study of 2921 pregnant patients with cardiomyopathy, we found no increased maternal morbidity with vaginal delivery compared with planned cesarean delivery.¹¹ However, further analysis by cardiomyopathy subtype is warranted because of differences in underlying pathophysiology.

The objective of this study was to examine the association of mode of delivery with maternal morbidity

events, inotropic medication use, and hospital readmissions in patients with differing types of cardiomyopathy: hypertrophic, dilated, peripartum, and other or unspecified. We hypothesized that, across all subtypes of cardiomyopathy, a trial of labor would not confer a higher risk of maternal morbidity when compared with planned cesarean delivery. We also hypothesized that inotrope use would be higher in patients with dilated or peripartum cardiomyopathy and in those requiring cesarean delivery compared with vaginal delivery. We aimed to provide insights into the optimal management strategies specific to varying types of cardiomyopathies to inform future practice.

Materials and methods

After institutional review board review and exemption, a retrospective cohort study was conducted using the Premier Healthcare inpatient administrative database. The cardiomyopathy cohort consisted of patients aged 12 to 55 years from January 1, 2016, to September 30, 2020, who had International Classification of Diseases, Tenth Edition (ICD-10) diagnosis codes for both delivery after 25 weeks' gestation (Z3A.25–Z3A.42) and cardiomyopathy. Cardiomyopathy subtypes were hypertrophic (I42.1–I42.2), dilated (I42.0), peripartum (O90.3), and other or unspecified

(I42.8–I42.9). Patients with both hypertrophic and other or unspecified cardiomyopathy were included in the hypertrophic subtype. Patients with both dilated and other or unspecified cardiomyopathy were included in the dilated subtype. Patients with both peripartum and other or unspecified cardiomyopathy were included in the peripartum subtype. Patients with any other combinations of cardiomyopathy diagnosis categories were excluded.

ICD-10 codes were also used to define vaginal delivery and cesarean delivery. Intrapartum cesarean deliveries were defined by ICD-10 codes for cesarean delivery plus fetal distress, failed operative delivery, cord prolapse, fetal-maternal disproportion, obstructed labor, abnormal forces of labor, long labor, or failed induction (Supplemental Table 1).¹² Cesarean deliveries without evidence of labor were classified as 'unlabored cesarean deliveries.' We used the term "unlabored" rather than "planned" because clinical intent cannot be reliably determined from administrative data.

The exposure variable of interest was mode of delivery. Data were analyzed on an intention-to-treat basis, comparing presumed intended vaginal delivery (vaginal delivery and intrapartum cesarean delivery) with intended cesarean delivery (unlabored cesarean delivery). The choice of this primary analysis was used to reflect clinical decision making when counseling pregnant patients on mode of delivery because providers cannot know with certainty whether a trial of labor will result in a vaginal delivery or intrapartum cesarean delivery. In addition, we also performed as-treated analyses, which compared completed vaginal delivery with all cesarean deliveries (intrapartum and unlabored cesarean deliveries). Outcomes were non-transfusion severe maternal morbidity (SMM) events (as defined by the Centers for Disease Control and Prevention) during birth hospitalization, blood transfusion (>4 units of packed red blood cells [pRBC]), readmission to the birth hospital within 90 days, intensive care unit (ICU) stay, and inotropic

medication use during birth hospitalization.¹³ These analyses were performed separately for all 4 cardiomyopathy subtypes.

Descriptive statistics were used to examine the study population. Patient characteristics were compared between the groups using Wilcoxon rank sum tests and chi-square or Fisher exact tests. Multivariable logistic regression models were used to compare outcomes by mode of delivery for both intention-to-treat and as-treated analyses. Covariates in the models were selected a priori and included age, payor category, and comorbidities (Supplemental Table 2).¹⁴ For the outcomes of SMM and readmission, the non-transfusion weighted index was used, and for the outcome of transfusion, the SMM weighted index was used.

Results

Cohort

The cohort consisted of 1872 deliveries: hypertrophic (n=233), dilated (n=203),

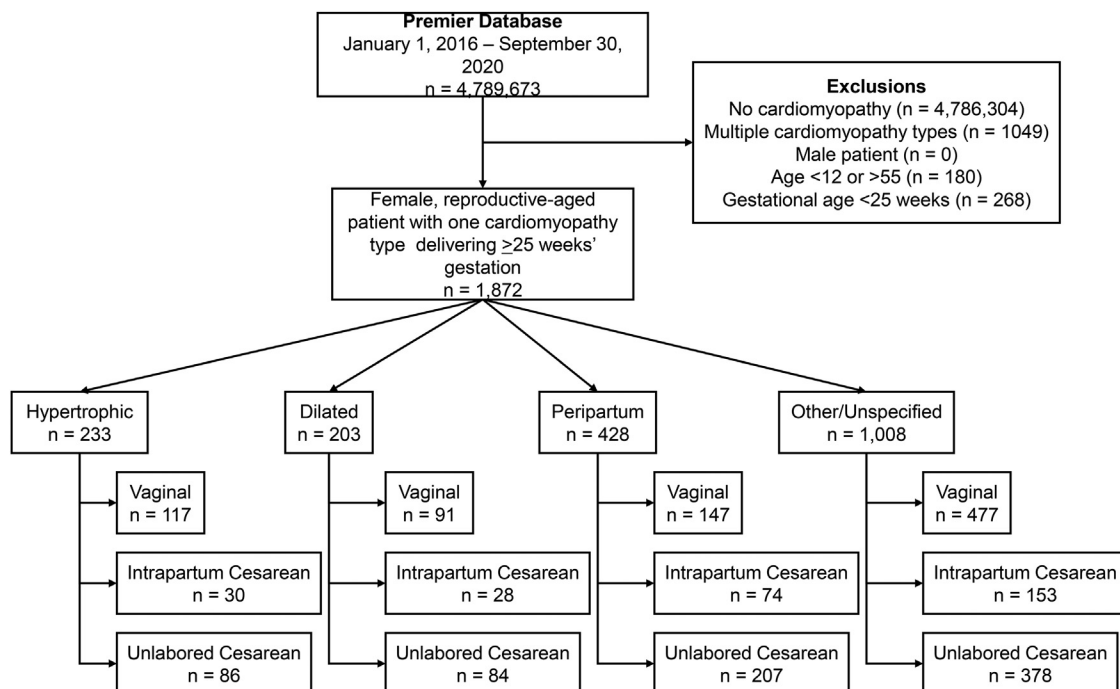
peripartum (n=428), and other or unspecified (n=1008) cardiomyopathy (Figure 1). Baseline characteristics, including age, insurance status, hospital characteristics, and comorbidities, are shown in Table 1 and Supplemental Table 2. The rate of intrapartum cesarean delivery (trial of labor resulting in cesarean delivery) was highest for peripartum cardiomyopathy (34%), followed by other or unspecified cardiomyopathy (24%), dilated cardiomyopathy (24%), and hypertrophic cardiomyopathy (20%). The rate of intrapartum cesarean delivery was 15% for all deliveries in this Premier Healthcare dataset. The rate of operative vaginal delivery among completed vaginal deliveries was higher across the cardiomyopathy cohort: dilated cardiomyopathy (18%), peripartum cardiomyopathy (16%), hypertrophic cardiomyopathy (13%), and other or unspecified cardiomyopathy (8%), compared with the rate of 6% for all deliveries in the Premier

Healthcare dataset. The rates of pre-eclampsia with severe features or hemolysis, elevated liver enzymes, and low platelet count syndrome among patients who delivered via cesarean delivery were highest for peripartum cardiomyopathy (33%), followed by other or unspecified cardiomyopathy (11%), hypertrophic cardiomyopathy (11%), and dilated cardiomyopathy (10%).

Severe maternal morbidity

The crude incidence of SMM events was highest for peripartum cardiomyopathy (32%), followed by dilated cardiomyopathy (18%), other or unspecified cardiomyopathy (11%), and hypertrophic cardiomyopathy (7%) (Table 2). Across all cardiomyopathy groups, SMM events occurred more frequently during cesarean delivery than during vaginal delivery. For all cardiomyopathy groups except hypertrophic cardiomyopathy, SMM events were more frequent during intrapartum cesarean delivery than

FIGURE 1
Derivation of study cohort



'Intention-to-treat' analyses compared intended vaginal deliveries (vaginal delivery+intrapartum cesarean delivery) and intended cesarean deliveries (unlabored Cesarean). 'As-Treated' analyses compared actual vaginal deliveries (vaginal) and actual cesarean deliveries (intrapartum cesarean delivery +unlabored cesarean delivery).

Meng. Type of cardiomyopathy and mode of delivery. *Am J Obstet Gynecol MFM* 2026.

TABLE 1

Selected baseline characteristics for hypertrophic, dilated, peripartum, and other or unspecified cardiomyopathy subtypes

		All completed VB	Intrapartum CB	Unlabored CB	Intention-to-treat: Intended Vaginal Delivery (VB + Intrapartum CB)	As-treated: All Cesarean Deliveries (Intrapartum + Unlabored CB)	P value	
							Intended	Actual
Hypertrophic		n=117	n=30	n=86	n=147	n=116		
	Age, y	29 (25–34)	32 (25–34)	31 (27–34)	29 (25–34)	31 (27–34)	.084	.068
Primary Payor	Managed care	44 (37.6%)	10 (33.3%)	28 (32.6%)	54 (36.7%)	38 (32.8%)	.165	.514
	Medicaid	50 (42.7%)	13 (43.3%)	44 (51.2%)	63 (42.9%)	57 (49.1%)		
	Medicare	1 (0.9%)	0 (0.0%)	3 (3.5%)	1 (0.7%)	3 (2.6%)		
	Other	22 (18.8%)	7 (23.3%)	11 (12.8%)	29 (19.7%)	18 (15.5%)		
	Prior cesarean delivery	6 (5.1%)	3 (10.0%)	40 (46.5%)	9 (6.1%)	43 (37.1%)	<.001	<.001
	Multiple gestation	1 (0.9%)	1 (3.3%)	5 (5.8%)	2 (1.4%)	6 (5.2%)	.055	.054
	Chronic hypertension	13 (11.1%)	6 (20.0%)	24 (27.9%)	19 (12.9%)	30 (25.9%)	.004	.004
	PEC-SF/HELLP	3 (2.6%)	3 (10.0%)	10 (11.6%)	6 (4.1%)	13 (11.2%)	.028	.009
	Preterm delivery	17 (14.5%)	9 (30.0%)	33 (38.4%)	26 (17.7%)	42 (36.2%)	.001	<.001
Dilated		n=91	n=28	n=84	n=119	n=112		
	Age, y	30 (25–34)	30 (25–36)	33 (29–36)	30 (25–34)	32 (28–36)	.003	.036
Primary payor	Managed care	27 (29.7%)	12 (42.9%)	21 (25.0%)	39 (32.8%)	33 (29.5%)	.043	.171
	Medicaid	49 (53.8%)	10 (35.7%)	43 (51.2%)	59 (49.6%)	53 (47.3%)		
	Medicare	2 (2.2%)	1 (3.6%)	10 (11.9%)	3 (2.5%)	11 (9.8%)		
	Other	13 (14.3%)	5 (17.9%)	10 (11.9%)	18 (15.1%)	15 (13.4%)		
	Prior cesarean delivery	3 (3.3%)	10 (35.7%)	42 (50.0%)	13 (10.9%)	52 (46.4%)	<.001	<.001
	Multiple gestation	2 (2.2%)	0 (0.0%)	7 (8.3%)	2 (1.7%)	7 (6.3%)	.023	.163
	Chronic hypertension	26 (28.6%)	9 (32.1%)	29 (34.5%)	35 (29.4%)	38 (33.9%)	.440	.414
	PEC-SF / HELLP	4 (4.4%)	5 (17.9%)	6 (7.1%)	9 (7.6%)	11 (9.8%)	.910	.142
	Preterm delivery	24 (26.4%)	15 (53.6%)	52 (61.9%)	39 (32.8%)	67 (59.8%)	<.001	<.001

(continued)

TABLE 1

Selected baseline characteristics for hypertrophic, dilated, peripartum, and other or unspecified cardiomyopathy subtypes (continued)

			All completed VB	Intrapartum CB	Unlabored CB	Intention-to-treat: Intended Vaginal Delivery (VB + Intrapartum CB)	As-treated: All Cesarean Deliveries (Intrapartum + Unlabored CB)	P value	
								Intended	Actual
Peripartum			n=147	n=74	n=207	n=221	n=281		
	Age, y		29 (25–34)	31 (25–36)	30 (26–35)	30 (25–35)	30 (26–35)	.700	.236
Primary payor	Managed care		33 (22.4%)	25 (33.8%)	52 (25.1%)	58 (26.2%)	77 (27.4%)	.613	.164
	Medicaid		96 (65.3%)	37 (50.0%)	118 (57.0%)	133 (60.2%)	155 (55.2%)		
	Medicare		7 (4.8%)	3 (4.1%)	10 (4.8%)	10 (4.5%)	13 (4.6%)		
	Other		11 (7.5%)	9 (12.2%)	27 (13.0%)	20 (9.0%)	36 (12.8%)		
Prior Cesarean delivery			4 (2.7%)	20 (27.0%)	92 (44.4%)	24 (10.9%)	112 (39.9%)	<.001	<.001
Multiple gestation			2 (1.4%)	3 (4.1%)	20 (9.7%)	5 (2.3%)	23 (8.2%)	.001	.004
Chronic hypertension			25 (17.0%)	19 (25.7%)	53 (25.6%)	44 (19.9%)	72 (25.6%)	.160	.043
PEC-SF/HELLP			21 (14.3%)	25 (33.8%)	68 (32.9%)	46 (20.8%)	93 (33.1%)	.005	<.001
Preterm delivery			57 (38.8%)	48 (64.9%)	125 (60.4%)	105 (47.5%)	173 (61.6%)	.008	<.001
Other/Unspecified			n=477	n=153	n=378	n=630	n=531		
	Age, y		31 (26–36)	32 (26–36)	32 (28–36)	31 (26–36)	32 (28–36)	.010	.033
Primary payor	Managed care		144 (30.2%)	52 (34.0%)	109 (28.8%)	196 (31.1%)	161 (30.3%)	.249	.047
	Medicaid		250 (52.4%)	74 (48.4%)	192 (50.8%)	324 (51.4%)	266 (50.1%)		
	Medicare		13 (2.7%)	10 (6.5%)	24 (6.3%)	23 (3.7%)	34 (6.4%)		
	Other		70 (14.7%)	17 (11.1%)	53 (14.0%)	87 (13.8%)	70 (13.2%)		
Prior cesarean delivery			30 (6.3%)	36 (23.5%)	233 (61.6%)	66 (10.5%)	269 (50.7%)	<.001	<.001
Multiple gestation			9 (1.9%)	3 (2.0%)	22 (5.8%)	12 (1.9%)	25 (4.7%)	.001	.013
Chronic hypertension			110 (23.1%)	58 (37.9%)	123 (32.5%)	168 (26.7%)	181 (34.1%)	.046	<.001
PEC-SF/HELLP			17 (3.6%)	26 (17.0%)	34 (9.0%)	43 (6.8%)	60 (11.3%)	.209	<.001
Preterm delivery			92 (19.3%)	91 (59.5%)	156 (41.3%)	183 (29.0%)	247 (46.5%)	<.001	<.001

Values are presented as median (interquartile range) for age and number (percentage) for all other results.

All CB, intrapartum cesarean delivery+unlabored cesarean delivery; CB, cesarean delivery; HELLP, hemolysis, elevated liver enzymes, and low platelets; Intended VB, vaginal delivery+intrapartum cesarean delivery; PEC-SF, preeclampsia with severe features; VB, vaginal delivery.

Meng. Type of cardiomyopathy and mode of delivery. Am J Obstet Gynecol MF 2026.

TABLE 2
Selected outcomes for hypertrophic, dilated, peripartum, and other/unspecified cardiomyopathy subtypes

		All Completed VB	Intrapartum CB	Unlabored CB	Intention-to-treat: Intended Vaginal Delivery (VB+Intrapartum CB)	As-treated: All Cesarean Deliveries (Intrapartum+Unlabored CB)	P value	
							Intended	Actual
Hypertrophic	SMM event (composite)	3 (2.6%)	2 (6.7%)	12 (14.0%)	5 (3.4%)	14 (12.1%)	.003	.005
	Intensive care stay	6 (5.1%)	9 (30.0%)	20 (23.3%)	15 (10.2%)	29 (25.0%)	.007	<.001
	Length of stay after delivery	1 (1–1)	2 (2, 3)	2 (1–3)	1 (1–2)	2 (2–3)	<.001	<.001
	42-day hospital readmission	1 (0.9%)	4 (13.3%)	8 (9.3%)	5 (3.4%)	12 (10.3%)	.058	.002
	90-day hospital readmission	2 (1.7%)	4 (13.3%)	8 (9.3%)	6 (4.1%)	12 (10.3%)	.106	.006
	Any inotrope use	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	N/A	N/A
	<4 Units pRBC blood transfusion	1 (0.9%)	2 (6.7%)	14 (16.3%)	3 (2.0%)	16 (13.8%)	<.001	<.001
	≥4 Units pRBC blood transfusion	1 (0.9%)	1 (3.3%)	2 (2.3%)	2 (1.4%)	3 (2.6%)	.627	.370
Dilated	SMM event (composite)	7 (7.7%)	10 (35.7%)	19 (22.6%)	17 (14.3%)	29 (25.9%)	.126	.001
	Intensive care stay	21 (23.1%)	13 (46.4%)	38 (45.2%)	34 (28.6%)	51 (45.5%)	.015	.001
	Length of stay after delivery	1 (1–2)	2 (2–5)	3 (2–4)	1 (1–2)	3 (2–4)	<.001	<.001
	42-day hospital readmission	3 (3.3%)	4 (14.3%)	7 (8.3%)	7 (5.9%)	11 (9.8%)	.497	.068
	90-day hospital readmission	3 (3.3%)	4 (14.3%)	7 (8.3%)	7 (5.9%)	11 (9.8%)	.497	.068
	Any inotrope use	7 (7.7%)	5 (17.9%)	8 (9.5%)	12 (10.1%)	13 (11.6%)	.895	.352
	<4 Units pRBC blood transfusion	9 (9.9%)	3 (10.7%)	8 (9.5%)	12 (10.1%)	11 (9.8%)	>.999	>.999
	≥4 Units pRBC blood transfusion	2 (2.2%)	2 (7.1%)	7 (8.3%)	4 (3.4%)	9 (8.0%)	.206	.116
Peripartum	SMM event (composite)	27 (18.4%)	36 (48.6%)	73 (35.3%)	63 (28.5%)	109 (38.8%)	.133	<.001
	Intensive care stay	43 (29.3%)	41 (55.4%)	105 (50.7%)	84 (38.0%)	146 (52.0%)	.008	<.001
	Length of stay after delivery	1 (1–3)	4 (2–5)	3 (2–5)	2 (1–4)	3 (2–5)	.008	<.001
	42-day hospital readmission	11 (7.5%)	6 (8.1%)	17 (8.2%)	17 (7.7%)	23 (8.2%)	.842	.799
	90-day hospital readmission	11 (7.5%)	6 (8.1%)	17 (8.2%)	17 (7.7%)	23 (8.2%)	.842	.799
	Any inotrope use	13 (8.8%)	8 (10.8%)	18 (8.7%)	21 (9.5%)	26 (9.3%)	.772	.889
	<4 Units pRBC blood transfusion	18 (12.2%)	15 (20.3%)	32 (15.5%)	33 (14.9%)	47 (16.7%)	.894	.257
	≥4 Units pRBC blood transfusion	3 (2.0%)	9 (12.2%)	7 (3.4%)	12 (5.4%)	16 (5.7%)	.353	.089

(continued)

TABLE 2
Selected outcomes for hypertrophic, dilated, peripartum, and other/unspecified cardiomyopathy subtypes (continued)

	All Completed VB	Intrapartum CB	Unlabored CB	Intention-to-treat: Intended Vaginal Delivery (VB+Intrapartum CB)	As-treated: All Cesarean Deliveries (Intrapartum+Unlabored CB)	P value	
						Intended	Actual
Other/Unspecified							
SMM event (composite)	28 (5.9%)	40 (26.1%)	41 (10.8%)	68 (10.8%)	81 (15.3%)	.979	<.001
Intensive care stay	50 (10.5%)	53 (34.6%)	80 (21.2%)	103 (16.3%)	133 (25.0%)	.055	<.001
Length of stay after delivery	1 (1–1)	3 (2–4)	2 (2–3)	1 (1–2)	2 (2–3)	<.001	<.001
42-day hospital readmission	26 (5.5%)	13 (8.5%)	14 (3.7%)	39 (6.2%)	27 (5.1%)	.087	.795
90-day hospital readmission	26 (5.5%)	13 (8.5%)	14 (3.7%)	39 (6.2%)	27 (5.1%)	.087	.795
Any inotrope use	30 (6.3%)	15 (9.8%)	21 (5.6%)	45 (7.1%)	36 (6.8%)	.324	.753
<4 Units pRBC blood transfusion	17 (3.6%)	22 (14.4%)	31 (8.2%)	39 (6.2%)	53 (10.0%)	.250	<.001
≥4 Units pRBC blood transfusion	3 (0.6%)	7 (4.6%)	13 (3.4%)	10 (1.6%)	20 (3.8%)	0.079	0.001

Values are presented as median (interquartile range) for length of stay after delivery and number (percentage) for all other results.

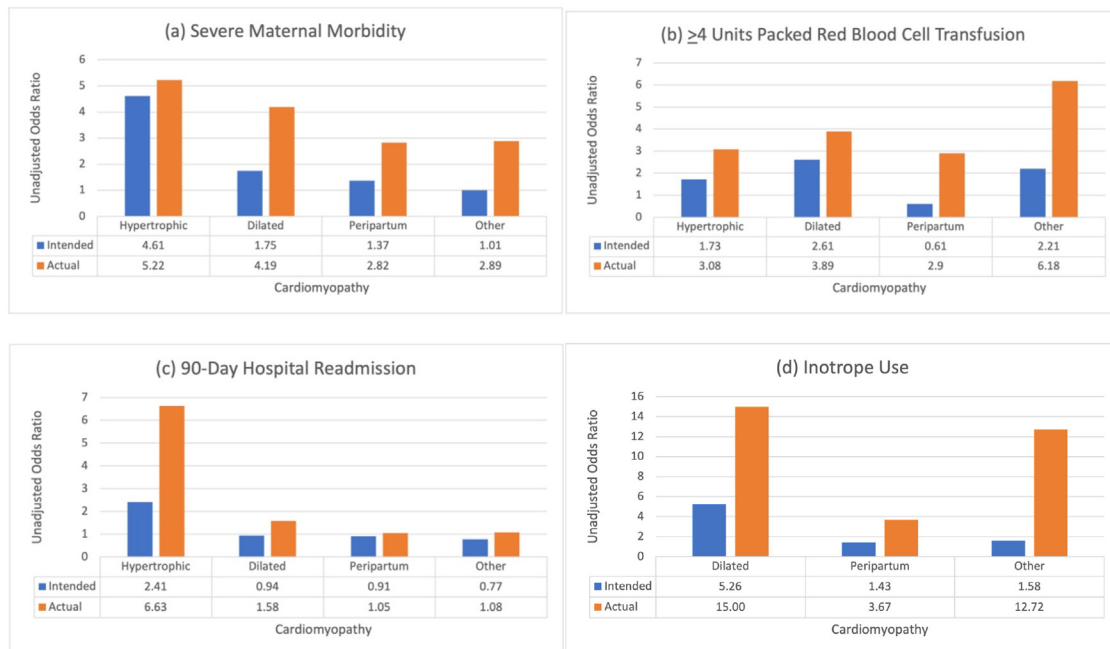
All CB, intrapartum cesarean delivery + unlabored cesarean delivery; CB, cesarean delivery; Intended VB, vaginal delivery + intrapartum cesarean delivery; N/A, not available; pRBC, packed red blood cells; SMM, severe maternal morbidity; VB, vaginal delivery.

Meng. Type of cardiomyopathy and mode of delivery. *Am J Obstet Gynecol* MFM 2026.

during unlabored cesarean delivery. In the hypertrophic cardiomyopathy cohort, intended vaginal delivery (including intrapartum cesarean delivery) had lower rates of SMM than planned cesarean delivery (3.4% vs 14%) ($P=.003$). The most common SMM events in the hypertrophic cardiomyopathy group were acute respiratory distress syndrome (5.8%), acute heart failure (3.5%), acute renal failure (3.5%), and disseminated intravascular coagulation (3.5%) ([Supplemental Table 3](#)). Among the 15 patients with hypertrophic cardiomyopathy who required operative vaginal delivery, there was only 1 episode of SMM (conversion of cardiac rhythm). In the dilated cardiomyopathy group, the most common SMM events were acute respiratory distress syndrome (8.2%), acute renal failure (7.8%), ventilation (7.4%), shock (7.3%), and acute heart failure (6.9%). In the peripartum cardiomyopathy group, the most common SMM events were ventilation (15.8%), acute respiratory distress syndrome (12.3%), acute heart failure (9.1%), shock (6.5%), and acute renal failure (6.5%) ([Supplemental Table 3](#)).

Patients with peripartum cardiomyopathy had a higher rate of SMM when compared with the previously published full cohort comprising all types of cardiomyopathies (31.7% vs 14.8%, respectively).¹¹ This increased rate of SMM in patients with peripartum cardiomyopathy was observed across all 3 modes of delivery when compared with the overall cohort of patients with cardiomyopathy ([Supplemental Table 3](#)).

In the primary analysis comparing intended vaginal delivery with intended cesarean delivery, differences were noted across cardiomyopathy type ([Figure 2](#); [Table 2](#); [Supplemental Tables 3 and 4](#)). Comparing intended cesarean delivery with intended vaginal delivery, there were higher odds of SMM with intended cesarean delivery among patients with hypertrophic cardiomyopathy (odds ratio [OR], 3.73 [1.18–11.82]). There were no significant differences in the odds of SMM among patients with dilated (OR, 1.50 [0.68–3.27]), peripartum (OR, 1.32 [0.87

FIGURE 2
Unadjusted odds ratios for outcomes

Intended (blue) and actual (orange) modes of delivery (cesarean vs vaginal). **A**, severe maternal morbidity. **B**, >4 units packed red blood cell transfusion. **C**, 90-day hospital readmission. **D**, inotrope use by cardiomyopathy subtype.

Meng. Type of cardiomyopathy and mode of delivery. *Am J Obstet Gynecol MFM* 2026.

−2.03]), or other (OR, 0.80 [0.51–1.24]) cardiomyopathy for intended cesarean vs intended vaginal delivery.

In the secondary analysis reclassifying patients based on their actual delivery route (regardless of whether a trial of labor was attempted), among patients who actually underwent cesarean delivery vs vaginal delivery, there were increased odds of severe morbidity among all cardiomyopathy subgroups: hypertrophic (OR, 3.98 [1.06–14.91]), dilated (OR, 4.05 [1.64–10.00]), peripartum (OR, 2.47 [1.50–4.07]), and other (OR, 2.18 [1.36–3.51]) (Table 3).

Blood transfusion

Rates of blood transfusion (>4 units) varied by cardiomyopathy subtype, with the lowest rates of transfusion among patients with hypertrophic cardiomyopathy (0.9% for vaginal delivery, 3.3% for intrapartum cesarean, and 2.3% for planned cesarean), followed by other cardiomyopathy (0.6% for vaginal delivery, 4.6% for intrapartum cesarean, and

3.4% for planned cesarean). Patients with dilated cardiomyopathy received transfusions (of >4 units pRBC) in 2.2% of vaginal deliveries, 7.1% of intrapartum cesarean deliveries, and 8.3% of planned cesarean deliveries, whereas patients with peripartum cardiomyopathy

received transfusions in 2.0% of vaginal deliveries, 12.2% of intrapartum cesareans, and 3.4% of planned cesarean deliveries (Table 2).

For the intention-to-treat analysis, there was no statistically significant difference in the risk of transfusion among

TABLE 3
Odds of severe maternal morbidity by cardiomyopathy subtype

	Mode of delivery	Odds ratio	95% CI	Interpretation
Hypertrophic	Intended	3.73	1.18–11.82	Higher Morbidity with intended cesarean
	Actual	3.98	1.06–14.91	Higher morbidity with actual cesarean
Dilated	Intended	1.50	0.68–3.27	No increased risk with trial of labor
	Actual	4.05	1.64–10.00	Higher morbidity with actual cesarean
Peripartum	Intended	1.32	0.87–2.03	No increased risk with trial of labor
	Actual	2.47	1.50–4.07	Higher morbidity with actual cesarean
Other/Unspecified	Intended	0.80	0.51–1.24	No increased risk with trial of labor
	Actual	2.18	1.24–14.95	Higher morbidity with actual cesarean

CI, confidence interval.

Meng. Type of cardiomyopathy and mode of delivery. *Am J Obstet Gynecol MFM* 2026.

any subgroup for intended cesarean vs intended vaginal delivery. For the as-treated analysis, the other cardiomyopathy subgroup had higher odds of transfusion (OR, 4.30 [1.24–14.95]) with cesarean delivery.

Intensive care unit care and hospital readmission

For the hypertrophic cardiomyopathy group, ICU care was required more frequently for cesarean delivery compared with vaginal delivery in both intention-to-treat (23.3% vs 10.2% [$P=.007$]) and as-treated (25.0% vs 5.1% [$P<.001$]) analyses, although this group had lower rates of ICU care compared with other subtypes (Table 2). For peripartum cardiomyopathy, ICU care was more frequently required for cesarean delivery compared with vaginal delivery in both the intention-to-treat (57.8% vs 38.3% [$P=.008$]) and as-treated (52.0% vs 29.3% [$P<.001$]) analyses. Similarly, for dilated cardiomyopathy, ICU care was more frequently required for cesarean delivery compared with vaginal delivery for both intention-to-treat and as-treated analyses.

Patients with peripartum cardiomyopathy had a higher rate of ICU stay among all modes of deliveries when compared with the full cohort of cardiomyopathies (all cardiomyopathies: vaginal delivery 13.4%, intrapartum cesarean delivery 29.6%, and cesarean delivery 29.4%; peripartum cardiomyopathy: vaginal delivery 29.3%, intrapartum cesarean delivery 55.4%, and cesarean delivery 50.7%).¹¹ Among patients with peripartum cardiomyopathy, there was a significantly higher prevalence of ICU stay with cesarean delivery in both primary (vaginal delivery 38% vs unlabored cesarean 50.7% [$P=.008$]) and secondary (as-treated vaginal delivery 29.3% vs as-treated cesarean delivery 52% [$P<.001$]) analyses. Among the intention-to-treat analyses, there was no significant difference between 90-day readmission for intended cesarean and intended vaginal delivery for any subgroup. For the as-treated analysis, cesarean delivery was associated with higher odds of

readmission (OR, 5.36 [1.14–25.21]) compared with vaginal delivery.

Inotrope use

For patients with dilated cardiomyopathy, inotrope use was higher in cesarean delivery compared with vaginal delivery in both intention-to-treat (OR, 4.62 [1.38–15.47]) and as-treated (OR, 13.64 [1.75–106.62]) analyses (Supplemental Table 4). Inotropes were used between 3 days before and 7 days after birth. The percentage of patients receiving any inotrope during this period varied between 2% and 6% and was highest on the day of birth. The day of highest use was 2 days before birth for dopamine, on the day of birth for epinephrine and dobutamine, and 7 days after birth for milrinone.

For patients with peripartum cardiomyopathy, there were no significant differences between cesarean delivery and vaginal delivery regarding inotrope use in intention-to-treat analyses. In as-treated analyses, patients who had a cesarean delivery were significantly more likely to use inotropes (17.4% vs 5.4% [$P=.001$]) compared with those who had vaginal delivery. Patients who had a cesarean delivery had significantly increased odds of inotrope use compared with those who had vaginal delivery (OR, 3.37 [1.52–7.47]). For patients with other cardiomyopathy, there was no significant difference in inotrope use in the intention-to-treat analysis. For the as-treated analysis, patients who underwent cesarean delivery had significantly higher odds of inotrope use (OR, 9.70 [2.26–41.59]). No inotropes were used in any patients with hypertrophic cardiomyopathy.

Mortality

Across the entire cohort, there were 10 in-hospital mortality events: 7 in the other or unspecified cardiomyopathy group (3 vaginal deliveries, 3 intrapartum cesarean deliveries, and 1 unlabored cesarean delivery) and 3 in the peripartum cardiomyopathy group (1 vaginal delivery and 2 unlabored cesarean deliveries) (Supplemental Table 3). There were no mortality events in either

the hypertrophic or dilated cardiomyopathy groups.

Comment

Principal findings

In this cohort, across all subtypes of cardiomyopathy, a trial of labor was not associated with greater SMM when compared with unlabored cesarean delivery. In patients with hypertrophic cardiomyopathy, a trial of labor was associated with lower odds of SMM when compared with unlabored cesarean delivery. However, among patients who delivered via cesarean delivery, the odds of SMM were higher across all subgroups, and the rates of SMM events among the group requiring intrapartum conversion to cesarean delivery were high, suggesting this population to be at the highest risk. Notably, the rates of intrapartum conversion to cesarean delivery and the rates of SMM events varied across subtypes of cardiomyopathy.

Clinical implications

These findings highlight important differences in the risks associated with the mode of delivery across clinical populations. Risks can be related to the procedure itself or differences in patient disease and its severity. In individuals with dilated, peripartum, or other cardiomyopathy, the primary analysis did not show a statistically significant difference in morbidity by intended delivery mode, suggesting that a trial of labor may be a reasonable and safe option in well-selected patients. However, the secondary analysis demonstrated a marked increase in morbidity among those who underwent cesarean delivery, particularly intrapartum cesarean delivery, reinforcing the importance of careful labor planning, real-time cardiac monitoring, and vigilance about mitigating increased risks when a trial of labor is unsuccessful in these patients. Although obstetrical indications for cesarean delivery may arise in any patient, patients with cardiomyopathy who are selected to undergo a trial of labor should have a favorable a priori chance of successful vaginal delivery, such as younger maternal age, lower

body mass index and gestational weight gain, and a favorable cervical examination.^{15,16} The elevated operative vaginal delivery rates in the cardiomyopathy cohort (8% to 18%) vs the general Premier Healthcare population (6%) likely reflect a deliberate shortening of the second stage. The risks and benefits of operative vaginal delivery are an important consideration when selecting the mode of delivery. The choice to perform a planned cesarean delivery to avoid possible maternal and neonatal morbidity from operative delivery when prolonged Valsalva is contraindicated is reasonable and may be desired by some patients.

In contrast to other cardiomyopathy subtypes, in the hypertrophic cardiomyopathy group, both analyses favored vaginal delivery over cesarean delivery, even among the patients who underwent a trial of labor but ultimately required a cesarean delivery. These findings suggest that a trial of vaginal delivery is preferred in this population and underscore the understanding that, compared with other types of cardiomyopathy, the hemodynamic changes of pregnancy and labor are generally well-tolerated in hypertrophic cardiomyopathy.^{12,17}

Research implications

Although a trial of labor is the recommended mode of delivery for most patients with cardiomyopathy, patients at greatest risk are those who require intrapartum conversion to cesarean. Prospective multicenter cardio-obstetric registries with detailed cardiovascular phenotyping, clinician-adjudicated diagnoses, and standardized collection of maternal, obstetrical, and institutional factors will be essential to identify patients at the highest risk for intrapartum cesarean delivery, optimize delivery planning, and refine individualized recommendations regarding mode of delivery.

Strengths and limitations

Limitations of this study relate primarily to the nature of the dataset. As an administrative dataset relying on billing and diagnosis codes, the Premier

Healthcare inpatient dataset lacks granular clinical detail. Over half of the population has an unspecified cardiomyopathy type, New York Heart Association (NYHA) functional class is unavailable,⁶ and echocardiographic parameters were not captured. Access to left ventricular ejection fraction (LVEF) would likely have been prognostic for severity of illness, and a lower LVEF would likely be associated with planned cesarean delivery.

Since diagnosis codes are assigned primarily for billing rather than research purposes, administrative datasets are susceptible to diagnostic misclassification. We could not validate the accuracy of ICD-10 coding for cardiomyopathy subtype within the Premier Healthcare database. Consequently, diagnostic misclassification is possible, particularly for specific cardiomyopathy subtypes. Such misclassification could have attenuated the observed differences between the groups and may partially explain the large proportion of patients classified as having unspecified or other cardiomyopathy. The large proportion of patients classified as having other or unspecified cardiomyopathy likely reflects, at least in part, the limitations of administrative coding and the absence of detailed clinical phenotyping. This limitation is particularly important because this heterogeneous subgroup demonstrated the highest observed rates of adverse maternal outcomes. Future studies using prospective registries or clinician-adjudicated diagnoses are needed to confirm these findings. Although large administrative datasets provide sufficient sample sizes to study rare conditions such as cardiomyopathy in pregnancy, they lack the detailed cardiovascular phenotyping necessary for individualized risk assessment. Future prospective multicenter registries incorporating NYHA functional class, modified World Health Organization classification, echocardiographic parameters, and other measures of disease severity will be essential to refine delivery recommendations and improve patient counseling.

For the hypertrophic cardiomyopathy cohort specifically, the absence of

left ventricular outflow tract (LVOT) gradient and Valsalva symptom data is notable because patients with severe LVOT obstruction or Valsalva-provoked symptoms are often recommended for planned cesarean delivery. Similarly, we were unable to distinguish obstructive from nonobstructive hypertrophic cardiomyopathy, despite important differences in pathophysiology, management, and pregnancy risk between these phenotypes. Because of this limitation of the dataset, we were unable to evaluate whether delivery outcomes vary between these important clinical subgroups.

The dataset also does not capture the acuity of diagnosis, which would likely influence both mode of delivery decisions and maternal morbidity outcomes. A patient presenting with acute decompensated heart failure and a new cardiomyopathy diagnosis is likely more acutely ill than one with a known, monitored cardiomyopathy or a prior peripartum cardiomyopathy diagnosis with recovered LVEF. Likewise, the database does not distinguish spontaneous preterm delivery from medically indicated preterm delivery. Because medically indicated preterm delivery may reflect worsening maternal cardiovascular status or obstetrical complications, we were unable to determine the extent to which preterm delivery influenced decisions regarding induction of labor or planned cesarean delivery.

Codes used to identify indications for cesarean delivery are likely applied imprecisely, and misclassification bias between patients with unlabored and intrapartum cesarean deliveries is possible. Institutional characteristics that likely influence maternal outcomes, including maternal level of care designation, availability of dedicated cardio-obstetrics programs, multidisciplinary expertise, and access to specialized cardiovascular, obstetrical, anesthesiology, and neonatal services, were not available in this administrative dataset. Future registries should incorporate these healthcare system variables to better evaluate the influence of care delivery models on maternal and neonatal outcomes.

The inclusion of the COVID-19 pandemic in the final year of the dataset may have altered delivery practice patterns. Several analyses yielded wide CIs, reflecting the low frequency of cardiomyopathy in pregnancy and the small number of events within specific cardiomyopathy subtypes and delivery mode strata. Accordingly, some effect estimates should be interpreted cautiously and considered hypothesis-generating. Larger prospective multicenter registries will be important to provide more precise estimates of risk. Our analysis did not include adjustment for race. In peripartum cardiomyopathy, race is associated with a worse outcome, including presentation with a lower LVEF and higher mortality rates.^{18,19} The reasons for this within the United States are likely to be multifactorial but may include social determinants of health, racism, and access to care. In our previous analysis of the Premier Healthcare dataset, we found that payor status statistically captured much of the variation associated with race and ethnicity, and therefore it was used in our analysis.²⁰ However, it is likely that there are other factors related to race and outcome not captured by this variable.

Despite these limitations, large administrative datasets remain uniquely valuable for studying rare conditions such as cardiomyopathy in pregnancy because they provide sample sizes that are otherwise difficult to achieve. Future prospective multicenter cardio-obstetrical registries incorporating clinician-adjudicated diagnoses, detailed cardiovascular phenotyping, echocardiographic parameters, delivery indications, institutional characteristics, and longitudinal maternal outcomes will be essential to validate these findings and refine individualized delivery recommendations for patients with cardiomyopathy.

Conclusion

Overall, this analysis underscores the value of individualized, condition-specific delivery planning. Our data suggest that in patients with cardiomyopathies diagnosed or known antepartum, in appropriately selected patients, a trial of labor does not significantly increase

maternal morbidity, blood transfusion risk, or readmission rates compared with cesarean delivery.

Among patients with hypertrophic cardiomyopathy, a trial of labor was associated with lower morbidity compared with a planned cesarean delivery, suggesting that either more morbid patients were selected for cesarean delivery or cesarean delivery was uniquely less optimal than vaginal delivery in this cohort compared with other cardiomyopathies. Although a trial of labor is the recommended mode of delivery for most patients with cardiomyopathy, patients at greatest risk are those who require intrapartum conversion to cesarean. Prospective studies are needed to determine the safe length of time in labor for these patients and the factors leading to unplanned cesarean delivery.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work, the author(s) used Copilot and ChatGPT to shorten text written by the authors. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article. ■

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Marie-Louise Meng: Writing — review & editing, Writing — original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Heather Acuff:** Writing — review & editing, Writing — original draft, Visualization, Investigation, Conceptualization. **Cosette Champion:** Writing — review & editing, Writing — original draft, Visualization, Investigation, Formal analysis. **Thais Peclat:** Writing — review & editing, Writing — original draft, Visualization, Data curation. **Matthew Fuller:** Validation, Methodology, Investigation, Formal analysis. **Katherine W. Arendt:** Writing — review & editing. **Kathryn J. Lindley:** Writing — review & editing. **Jerome Federspiel:**

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Supplementary materials

Supplementary material associated with this article can be found in the online version at [doi:10.1016/j.ajogmf.2026.102095](https://doi.org/10.1016/j.ajogmf.2026.102095).

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