

EDITORIAL COMMENT

Severe Maternal Cardiovascular Morbidity Below the Tip of the Iceberg*



Joan E. Briller, MD

The rising contribution of cardiovascular disease to maternal mortality has been clearly documented. However, mortality is the tip of the iceberg. Approximately 700 women die annually in the United States, but up to 60,000 suffer pregnancy-associated morbidity.¹ Severe maternal morbidity (SMM), defined as potentially life-threatening events during labor and delivery, is an integral component of maternal health. In the United States, where most obstetric deliveries occur in a hospital setting, discharge data are a valuable source for maternal health surveillance. Centers for Disease Control data show that overall SMM has been rising. Even after exclusion of those requiring transfusion, SMM increased 20% from 1993 to 2014 reaching 35 per 10,000 delivery hospitalizations.¹ The reasons for this are not completely clear but attributed to older age, obesity, preexisting chronic medical conditions, and cesarean delivery. In addition to mortality, SMM is associated with longer lengths of hospital stay, increased medical costs, and long-term adverse outcomes. The contribution of severe cardiovascular morbidity (CSMM) to this rising incidence has not been well studied.

In this issue of the *JACC: Advances*, Malhamé et al² analyzed delivery hospitalizations from the National Inpatient Sample (NIS) of the Health Care Cost and Utilization Project for CSMM from 1999 to 2015 based on the International Classification of Diseases (ICD)

9th Revision Codes using a validated composite measure from the Centers for Disease Control for cardiovascular morbidities such as myocardial infarction, aneurysm, cerebral vascular disorders, ventricular fibrillation, and pulmonary edema. Overall CSMM constituted approximately 8 per 10,000 deliveries, a substantial burden. The authors addressed baseline demographic characteristics, pregnancy-related characteristics such as hemorrhage, hypertensive pregnancy disorders, gestational diabetes, peripartum cardiomyopathy, and underlying cardiac conditions such as valvular heart disease.²

Paralleling the rise in overall maternal morbidity, they found an 8% rise in CSMM over the study period. Not surprisingly, they found racial and ethnic disparities with increased morbidity in Black and Hispanic populations. Social disparities also contributed with increased incidence in Medicaid patients. Comorbidities including pre-existing cardiovascular disease, hypertension, and risk factors for cardiovascular diseases were common. An encouraging finding was a decreasing case fatality rate in the presence of a morbidity event. Unfortunately, as the authors point out, morbidity and mortality remain depressingly high.

The most common CSMM complications were pulmonary edema and cerebral vascular disorders. Mortality was highest for those requiring rhythm conversion, ventricular fibrillation, and cardiogenic shock and lowest in the setting of pulmonary edema.

Black women have higher rates of pregnancy-associated myocardial infarction, stroke, pulmonary embolism, and peripartum cardiomyopathy than White women.³⁻⁵ Brown et al⁵ recently addressed the association between comorbidities and overall SMM in the NIS 2016 to 2017. More chronic health conditions were present in Black women. Moreover, there was a dose-response relationship. Highest rates of SMM were present in those with 3 or more comorbidities, but even

*Editorials published in *JACC: Advances* reflect the views of the authors and do not necessarily represent the views of *JACC: Advances* or the American College of Cardiology.

From the Division of Cardiology, Department of Medicine and Department of Obstetrics and Gynecology, University of Illinois-Chicago, Chicago, Illinois, USA.

The author attests they are in compliance with human studies committees and animal welfare regulations of the author's institution and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the [Author Center](#).

women with 1 comorbidity were more likely to have morbidity events than those with none. Understanding the interactions between race and chronic conditions with adverse maternal cardiovascular outcomes may inform policy and strategies to reduce morbidity as well as mortality.

Unfortunately, this report only addresses outcomes in delivery hospitalizations. Declercq et al⁶ reported a 22% increase in SMM by linking discharge to antenatal and postpartum data. Up to 14% to 16% of overall SMM presents de novo following discharge.⁷ One distinguishing aspect of maternal cardiovascular disease is that it frequently presents postpartum. Mogos et al⁸ addressed heart failure admissions across the pregnancy continuum in the NIS and found that heart failure was most common postpartum and associated with adverse outcomes including mortality. Lima et al⁹ found that 42-day readmission rates for cardiovascular and cerebrovascular complications were greater in those with an underlying cardiovascular disease, especially cardiomyopathy. Moreover, clinical events at delivery such as preeclampsia, postpartum hemorrhage, preterm delivery, and thrombotic complications were predictive of rehospitalization. Therefore, CSMM is likely to be underestimated in this study.

Studies based on diagnosis codes have inherent weaknesses since ICD coding does not always completely define the underlying medical circumstances. NIS data only identify events coded at the time of discharge. An intensive care unit admission postpartum for monitoring a woman with a complex congenital heart disease may be appropriate rather than a morbidity event compared with an intensive care unit admission for acute heart failure. In this study, for example, we do not know if rhythm conversion represents an elective procedure or a rhythm disturbance that could be associated with subsequent cardiac arrest.

In addition, we are not able to address the most current trends in cardiac morbidity since this study completed analysis with 2015 data. In October 2015, U.S. hospitals changed to using ICD-10th Revision Discharge Codes. One study assessing this transition on overall SMM found an immediate drop of almost 9%, presumably due to coding changes rather than an improvement in outcomes. The transition from ICD-9th Revision to ICD-10th Revision coding limits our ability to assess interventions which span across the 2 coding systems.¹⁰ Moving forward, we will need

systematic data to assess the impact of interventions to reduce morbidity.

The importance of morbidity in patients with a known cardiovascular disease in the NIS has been previously reported. Lima et al⁹ found increasing prevalence over time of myocardial infarction, arrhythmias, cerebral vascular events, embolic events, and anesthesia complications during delivery hospitalizations in this group. The incidence was highest in patients with cardiomyopathy and pulmonary hypertension and lowest in women with congenital heart disease. Schlichting et al addressed delivery complications in women with congenital heart disease finding an increased likelihood of heart failure, arrhythmias, thromboembolic complications, and preeclampsia.¹¹

A key message from this investigation is that CSMM was highest in those without a previously documented cardiac disease. This underscores the importance of vigilance in looking for complications and a need to identify preceding risk factors to develop appropriate prevention strategies. In a prospective analysis of 1,315 pregnancies in women with a known heart disease, almost one-half of serious events were considered preventable.¹² Common care errors included failure to identify patients at high risk, late recognition of status deterioration, and treatment mistakes. Data from the CARPREG II (Cardiac Disease in Pregnancy) cohort found a decreasing prevalence of pulmonary edema over time without a substantial change in level of risk.¹³ This suggests we can mitigate complications when we recognize women at risk. But, if we wait until “red flags” such as markedly abnormal vital signs develop, the morbidity event could already be in progress.

Ideally, women’s cardiovascular health should be addressed and optimized prior to pregnancy, and underlying cardiac risks appropriately managed during pregnancy to minimize adverse events. A detailed review of cases with cardiovascular morbidities—as is performed for maternal mortality—should help determine whether the morbidity was avoidable and focus our attention on solutions that ensure quality care.

Ultimately, strategies to reduce maternal cardiovascular morbidities will require multiple avenues of approach, but this study confirms our perception that maternal cardiac morbidity is increasing and is more prevalent in Blacks, those with chronic disease, and others with socioeconomic risk factors. The findings in this study should be used to drive changes in

health care delivery, enhance research spending on cardiovascular diseases in pregnancy, and prompt continued expansion in Medicaid coverage in the first year postpartum.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

Dr Briller is an unpaid consultant for the Illinois Maternal Mortality Committee; and is on the steering committee of and a site investigator for National Institutes of Health-funded (NCT05180773) Impact

of Bromocriptine on Clinical Outcomes for Peripartum Cardiomyopathy (REBIRTH).

ADDRESS FOR CORRESPONDENCE: Dr Joan E. Briller, Division of Cardiology, Department of Medicine and Department of Obstetrics and Gynecology, University of Illinois Chicago, 840 South Wood Street (mc 715), Chicago, Illinois 60612, USA. E-mail: briller@uic.edu. Twitter: [@UICDom](https://twitter.com/UICDom).

REFERENCES

- Centers for Disease Control and Prevention. Severe Maternal Morbidity in the United States. Accessed August 25, 2022. https://www.cdc.gov/reproductivehealth/maternalinfanthealth/severematernalmorbidity.html#anchor_trends
- Malhamé I, Czuzoj-Shulman N, Abenheim HA. Cardiovascular severe maternal morbidity and mortality at delivery in the United States: a population-based study. *JACC Adv*. 2022;1(4):100121.
- Mehta LS, Warnes CA, Bradley E, et al. Cardiovascular considerations in caring for pregnant patients: a scientific statement from the American Heart Association. *Circulation*. 2020;141:e884-e903.
- Shah LM, Varma B, Nasir K, et al. Reducing disparities in adverse pregnancy outcomes in the United States. *Am Heart J*. 2021;242:92-102.
- Brown CC, Adams CE, George KE, Moore JE. Associations between comorbidities and severe maternal morbidity. *Obstet Gynecol*. 2020;136:892-901.
- Declercq ER, Cabral HJ, Cui X, et al. Using longitudinally linked data to measure severe maternal morbidity. *Obstet Gynecol*. 2022;139:165-171.
- Chen J, Cox S, Kuklina EV, Ferre C, Barfield W, Li R. Assessment of incidence and factors associated with severe maternal morbidity after delivery discharge among women in the US. *JAMA Netw Open*. 2021;4:e2036148.
- Mogos MF, Piano MR, McFarlin BL, Salemi JL, Liese KL, Briller JE. Heart failure in pregnant women: a concern across the pregnancy continuum. *Circ Heart Fail*. 2018;11:e004005.
- Lima F, Nie L, Yang J, et al. Postpartum cardiovascular outcomes among women with heart disease from a Nationwide study. *Am J Cardiol*. 2019;123:2006-2014.
- Metcalfe A, Sheikh M, Hetherington E. Impact of the ICD-9-CM to ICD-10-CM transition on the incidence of severe maternal morbidity among delivery hospitalizations in the United States. *Am J Obstet Gynecol*. 2021;225:422.e1-422.e11.
- Schlichting LE, Insaif TZ, Zaidi AN, Lui GK, Van Zutphen AR. Maternal comorbidities and complications of delivery in pregnant women with congenital heart disease. *J Am Coll Cardiol*. 2019;73:2181-2191.
- Pfaller B, Sathananthan G, Grewal J, et al. Preventing complications in pregnant women with cardiac disease. *J Am Coll Cardiol*. 2020;75:1443-1452.
- Silversides CK, Grewal J, Mason J, et al. Pregnancy outcomes in women with heart disease: the CARPREG II study. *J Am Coll Cardiol*. 2018;71:2419-2430.

KEYWORDS adverse pregnancy outcomes, cardio-obstetrics, delivery hospitalizations, social disparities