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Editorial

The Cardio-Obstetrics Patient and the Cardiothoracic Anesthesiologist

Maternal mortality is at an all-time high in the United States, with maternal cardiac disease being the leading cause of death.[1] National calls to improve maternal care before, during, and after pregnancy prompt all subspecialties to identify ways to mitigate maternal morbidity and mortality.[2] Cardiothoracic anesthesiologists can contribute to maternal care in unique ways, presenting great opportunity for the field to answer this call and improve maternal outcomes.

Recent national efforts to standardize maternal care include the formation of Pregnancy Heart Teams to improve the care of high-risk cardio-obstetric patients and the designation of Maternal Levels of Care to provide risk-appropriate care to all women.[3,4] Pregnancy Heart Teams are multidisciplinary teams with specific expertise in obstetrics, maternal-fetal medicine, cardiology, nursing, pharmacy, obstetric anesthesiology, and, when necessary, cardiothoracic anesthesiology and cardiac surgery. Pregnancy Heart Teams create individualized peripartum care plans for cardio-obstetric patients. Women with modified World Health Organization (mWHO) group III and IV lesions should be cared for at Maternal Level of Care Level III or IV centers. Level III centers must have subspecialists in critical care and cardiology; to qualify as a Maternal Level of Care Center Level IV, a center must have a cardiac surgery program. The cardiothoracic anesthesiologist, by virtue of working at a center with cardiac surgery, will likely practice at a Level IV center where women with the highest pregnancy risk will seek obstetric care.

In last month's edition of this *Journal*, Dr. Wolla et al provided an example of expert anesthetic management of a patient with severe pulmonary hypertension who required termination of pregnancy due to maternal decompensation.[5] The authors here wish to praise specific aspects of the care and emphasize (1) the risk of undiagnosed cardiac disease in pregnancy, (2) the medical need for the termination of pregnancy in certain situations, and (3) the role of the cardiothoracic anesthesiologist in assisting the obstetric anesthesiologist.

Dr. Wolla et al outlined the challenges that the physiology of pregnancy poses in patients with pulmonary hypertension. Pregnancy in patients with pulmonary hypertension carries a mortality rate of 16%, with group-1 pulmonary hypertension carrying the highest risk of mortality, with reported mortality rates of 23%-to-43% for idiopathic pulmonary hypertension.[6,7] For this reason, pulmonary hypertension is considered an mWHO group-IV lesion, the highest-risk group of cardiac diseases in pregnancy. Women with mWHO group-IV lesions are counseled against pregnancy and advised to terminate a pregnancy should it occur.[8]

Expert opinion and multiple cases series have demonstrated the safety of neuraxial anesthesia for vaginal and cesarean delivery in patients with pulmonary hypertension.[6,9,10] As discussed by Dr. Wolla et al, neuraxial analgesia is absolutely essential to facilitate a safe vaginal delivery and is strongly recommended over general anesthesia when cesarean delivery is necessary.[6,9,10] While the cardiothoracic anesthesiologist is adept at and familiar with providing general endotracheal anesthesia to the patient with pulmonary hypertension, the pregnant patient with pulmonary hypertension about to undergo delivery of the fetoplacental unit poses the additional challenge of large preload changes peri- and postdelivery. These fluid shifts precipitate additional increases and decreases in right ventricular filling and pulmonary flow, resistance, and pressure, and the authors here believe that the avoidance of mechanical ventilation in this setting may be useful. The obstetric anesthesiologist, of course, is more familiar and comfortable with cesarean delivery with neuraxial anesthesia. This scenario provides a perfect arena for collaboration between the 2 subspecialties.

The appropriate use of pulmonary vasodilators and diuresis in this patient likely contributed to the good maternal outcome. The authors opined that the administration of a 1-L fluid bolus at the time of initiation of epidural analgesia likely was unnecessary and possibly an error, but did not result in harm due to prior diuretic therapy. While a liter of crystalloid may not have been absolutely necessary, and usually is not necessary in healthy parturients, there may have been some role for moderate fluid administration (and/or moderate vasopressor infusion

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therapy) to maintain preload, critical in many patients with pulmonary arterial hypertension, with diuresis remaining the "rescue" strategy. An arterial line would seem to be quite useful in this regard, and it is not clear if there was one present. While there is concern for pulmonary artery rupture or arrhythmia with the use of a pulmonary artery catheter, Dr. Wolla et al demonstrated the utility of this monitor peripartum, and the authors here encourage pulmonary artery catheter use by expert teams in the interpretation of the data provided by pulmonary artery catheters and in settings in which pulmonary vasodilator medications are being rapidly titrated. If a pulmonary artery catheter is used, simple precautions to lessen the risk of rupture include very limited use of balloon inflation and wedge pressure measurements, and, generally, the catheter should be left in a position that will not allow it to wedge.

It is imperative to note that this patient, along with countless other women, had congenital or acquired heart disease that was undiagnosed through childhood, only manifesting with the physiologic stress of pregnancy. In the authors' practice, they have seen many of these patients coming from the developing world with undiagnosed severe cardiac disease, but this scenario also occurs in the developed world, and pulmonary arterial hypertension may develop (or present) during pregnancy. As Wolla et al described, the physiologic stress specific to women with pulmonary hypertension who become pregnant is the increased circulating blood volume that leads to higher flow through the pulmonary circulation and increased pulmonary pressures. This increase in pulmonary pressure can lead to right-heart decompensation in the second or third trimester. There is a somewhat lesser but still real risk from moderate-to-severe postpartum hemorrhage, which can lead to an underfilled right ventricle, unable to generate enough pressure or flow through a high-pressure pulmonary circulation. Therefore, this patient and many others are faced with the incredibly challenging decision to terminate a possibly very desired pregnancy. Although termination is often recommended and probably a very appropriate option, it should be acknowledged that it is not completely clear that termination in the late second trimester is much less risky than delivery in the mid-third trimester.[6]

The CARPREG II risk stratification index by Silversides et al is a useful guide for the prediction of adverse cardiac events in women with cardiac disease. The index includes a variable related to process of care, delayed access to care, or late pregnancy assessment as a risk factor for adverse events. Delayed identification of pulmonary hypertension in this patient corresponded to a 15% predicted incidence of an adverse cardiac event. When the physiologic challenges of pregnancy unmask underlying severe cardiac disease, patients are at high risk of severe morbidity and mortality and may require termination of pregnancy. These are the cases in which the cardiothoracic anesthesiologist may have the potential to improve care and outcomes.

Case series demonstrated that mortality within 1 year of delivery is higher in women with severe pulmonary hypertension versus those with mild pulmonary hypertension, 21%-to-22% *v* 9%.[6,11] This case describes a patient with severe pulmonary hypertension who should be counseled against pregnancy, and for early (preferably first trimester) termination should pregnancy occur. Current attempts to curtail the medically necessary use of terminations of pregnancy do a disservice, potentially fatal, to women with an undiagnosed cardiac disease whose illness becomes manifest at or after the late first trimester as pregnancy blood volume and cardiac output increase.

In this case, the patient was faced with the challenging decision of continuing pregnancy for an uncertain amount of time before her probable cardiopulmonary decompensation, potentially resulting in an emergency delivery, which almost all series have indicated is the most dangerous scenario, or terminating the pregnancy and avoiding the birth of a severely preterm neonate.[6] Either way, this patient had a very high risk of maternal morbidity and mortality, so the decision centered around the possibility of a severe preterm neonate with a critically ill mother. The short- and long-term consequences of prematurity are not insignificant. Short-term consequences of prematurity include respiratory compromise, bronchopulmonary dysplasia, apnea, patent ductus arteriosus, hypotension, intraventricular hemorrhage, temperature control problems, hypoglycemia, necrotizing enterocolitis, anemia, newborn jaundice, and infection from immature immune systems. Long-term consequences of prematurity include cerebral palsy, impaired learning, vision and hearing problems, dental problems, behavioral and psychological problems, and other chronic health issues. The ethics of a mother with severe pulmonary hypertension with a preterm neonate are, to say the least, complex, and should be approached with compassion and individualized, as in this case.

When pregnancy is noted in a patient with a high-risk cardiac lesion and termination is advised, the earlier the termination occurs, the less hemodynamic consequence and risk the pregnancy, termination, and recovery will pose to the mother. As stated above, termination is not proven safer than the continuation of pregnancy for maternal health at this point of 23 weeks' gestation, but termination does avoid a severely preterm birth. Hence, the early identification of maternal cardiac disease is imperative.

A recent review for the cardiac anesthesiologist outlined how the cardiac anesthesiologist can help the obstetric or general anesthesiologist in the care of the cardio-obstetric patient.[12] Both the CARPREG II risk score and mWHO grouping can aid in identifying patients who are at high risk of cardiovascular morbidity and mortality and for whom a cardiothoracic anesthesiologist may be an essential member of the "Pregnancy Heart Team."[4,13,14] Cardiac anesthesiologists may aid in echocardiography image acquisition and interpretation, inotrope titration, and facilitation of mechanical support (eg, extracorporeal membrane oxygenation) when necessary. This case demonstrated that the skills of a cardiothoracic anesthesiologist may be necessary not just for patients who are having vaginal or cesarean delivery, but also for patients who require terminations of pregnancy. If a cardio-obstetric patient is sick enough to need a termination of pregnancy, she may

well be sick enough to need the care of a cardiothoracic anesthesiologist.

Editorials or commentaries regarding case reports are uncommon; however, this case highlighted a unique and critical area for the subspecialty to consider. As this subspecialty increases its role in the care of the cardio-obstetric patient and contributes to the data and scientific literature surrounding how these patients are cared for, acute maternal morbidity in this population may diminish. The authors encourage the cardiothoracic anesthesiologist to partner with the obstetric anesthesiologist, as the bidirectional flow of knowledge and experience will certainly improve the care of childbearing patients.

Conflict of Interest

Dr. Meng denies any potential conflicts of interest including commercial relationships, such as consultation and equity interests. Dr. Meng is currently supported by the NIH T32 GM 008600-25. Dr. Smiley's wife owns stock in the following healthcare/pharmaceutical firms: Abbvie, Amgen, Merck, Pfizer, and United Health Group. Dr. Smiley received research funding in 2020 from Pacira Pharmaceuticals.

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