


MINI-REVIEW

Improving Cardiovascular Workforce Competencies in Cardio-Obstetrics: Current Challenges and Future Directions

Garima Sharma , MD; Sammy Zakaria, MD, MPH; Erin D. Michos, MD, MHS; Ami B. Bhatt, MD; Gina P. Lundberg, MD; Karen L. Florio, DO; Arthur Jason Vaught, MD; Pamela Ouyang, MBBS; Laxmi Mehta, MD

ABSTRACT: Maternal mortality in the United States is the highest among all developed nations, partly because of the increased prevalence of cardiovascular disease in pregnancy and beyond. There is growing recognition that specialists involved in caring for obstetric patients with cardiovascular disease need training in the new discipline of cardio-obstetrics. Training can include integrated formal cardio-obstetrics curricula in general cardiovascular disease training programs, and developing and disseminating joint cardiac and obstetric societal guidelines. Other efforts to help strengthen the cardio-obstetric field include increased collaborations and advocacy efforts between stakeholder organizations, development of US-based registries, and widespread establishment of multidisciplinary pregnancy heart teams. In this review, we present the current challenges in creating a cardio-obstetrics community, present the growing need for education and training of cardiovascular disease practitioners skilled in the care of obstetric patients, and identify potential solutions and future efforts to improve cardiovascular care of this high-risk patient population.

Key Words: cardio-obstetrics ■ cardiovascular disease prevention ■ preeclampsia/pregnancy ■ pregnancy and postpartum ■ training

Cardiovascular disease (CVD) is the leading cause of maternal morbidity and mortality in the United States and accounts for 26.5% of pregnancy-related deaths.¹⁻³ Although other countries have had a decline in maternal mortality, the US rate has continued to increase for the past 14 years, partially because of increased prevalence of CVD and its risk-factors.⁴ CVD can directly lead to peripartum morbidity and mortality. In addition, some pregnancy-specific conditions, particularly hypertensive disorders of pregnancy, can lead to short-term and long-term cardiovascular events, such as peripartum cardiomyopathy, chronic hypertension, or accelerated CVD.^{5,6} Although CVD and pregnancy-specific conditions can be managed during pregnancy, identifying women at high risk and optimizing antenatal, birth, and postpartum care require care from multiple specialties. In addition to maternal-fetal medicine specialists, these women need cardiologists with focused expertise in cardio-obstetrics. In

this article, we review the spectrum of preexisting- or pregnancy-associated CVD that requires management by cardiologists trained in cardio-obstetrics; identify current gaps in training and opportunities to improve cardio-obstetric competencies; and describe the role of multidisciplinary approaches, research, professional societies, advocacy, and social medial networks in championing the care of this unique population.

PREEXISTING AND PREGNANCY-ASSOCIATED CVD

CVD may be preexistent or develop during pregnancy or in the postpartum period. For women with established CVD (eg, coronary artery disease, pulmonary hypertension, valvular disease, cardiomyopathies, arrhythmias, aortopathies, adult congenital heart disease, and genetic cardiac syndromes), the

Correspondence to: Garima Sharma, MD, Division of Cardiology, Department of Medicine, Johns Hopkins University School of Medicine, 1800 Orleans St, Zayed 7125 A, Baltimore, MD 21287. E-mail: gsharma8@jhmi.edu

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management of pregnancy and CVD has been previously addressed in guidelines and obstetrical practice bulletins.^{3,7-9} The care of this population requires a multidisciplinary approach, starting with preconception counseling and categorization of risk, and ending with recommendations for lactation, mental health, and conception planning.³

There are fewer recommendations addressing cardiovascular health in other groups of pregnant women. Approximately 20% of pregnant women develop adverse pregnancy outcomes (APOs), including fetal growth restriction, placental abruption, preterm delivery, gestational diabetes mellitus, or hypertensive disorders of pregnancy.^{10,11} Most APOs are associated with decreased uterine artery blood flow, vascular endothelial dysfunction, inflammation, and vasospasm,¹²⁻¹⁴ all of which may increase the risk of short- and long-term CVD events.^{5,10-13} In particular, hypertensive disorders of pregnancy, especially the subset with preeclampsia, increase the risk of acute cardiovascular events and chronic hypertension, left ventricular dysfunction, heart failure, coronary artery disease, stroke, and renal dysfunction.^{5,6,15} However, many CVD specialists are not aware of the risks posed by APOs, and few incorporate a detailed pregnancy history in their risk assessment of women,¹⁶⁻¹⁸ although preeclampsia is considered a risk enhancer in newer atherosclerotic CVD risk-assessment tools.^{10,11,19,20}

In summary, pregnancy associated with manifestations of CVD or APOs should trigger efforts to engage women to understand their future CVD risk (Figure 1).

More important, these patients need counseling to develop sustainable healthy lifestyle choices as well as undertake treatments that could reduce subsequent CVD risk.

IMPROVING CARDIO-OBSTETRICS TRAINING

Because pregnancy can unmask or lead to acute and chronic CVD, there is a strong need for training in cardio-obstetrics. At a minimum, establishment of clinical workforce competencies for general CVD specialists and the widespread implementation of cardio-obstetric subspecialty fellowships can help focus the CVD community to prevent, detect, risk stratify, and optimally treat CVD in pregnancy while addressing the long-term cardiac needs of this population. The clinical areas of focus should include the following: (1) preconception risk stratification and counseling in patients with existing CVD; (2) health optimization before pregnancy; (3) personalizing antenatal care and delivery on the basis of risk profile; and (4) early diagnosis and treatment of complications during pregnancy and postpartum.

However, most CVD fellowship training programs currently do not provide extensive exposure to cardio-obstetrics, although the Accreditation Council for Graduate Medical Education requires that all CVD fellowship programs cultivate competence in preventing, evaluating, and managing heart disease in pregnancy.²¹ However, there are no specific recommendations addressing cardio-obstetric care beyond

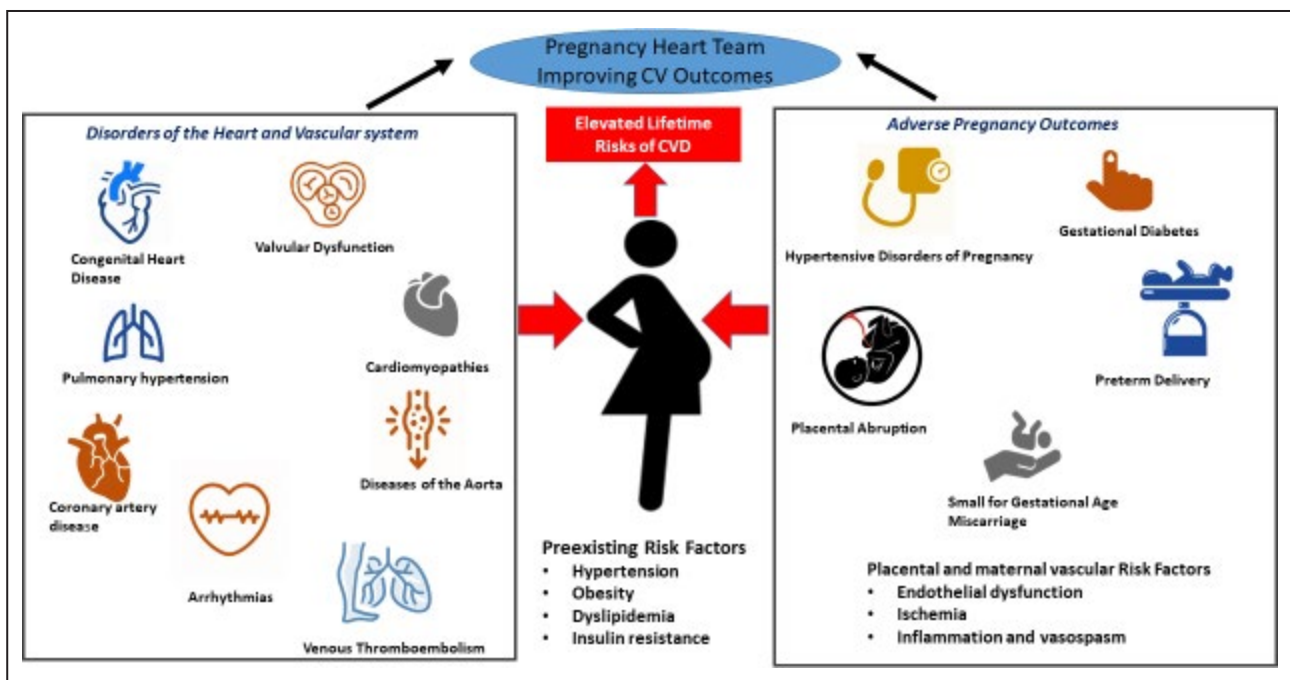


Figure 1. Preexisting and pregnancy-associated cardiovascular disease (CVD) affecting maternal morbidity and mortality.

mandating outpatient clinic experiences that include patients of varied ages and sex, which presumably would include pregnant women.²¹ Similarly, the American Board of Internal Medicine does not have a cardio-obstetrics category in the certification examination blueprints, and has no mandates devoted to this population.²² Finally, Core Cardiology Training Statement CVD fellowship training guidelines do encourage exposure to pregnant women with heart disease in high-risk obstetrical clinics.²³ Trainees are also required to learn the impact of pregnancy on the risk of CVD or heart failure, as well as becoming proficient in managing the complications of pregnant patients with valvular heart disease, adult congenital heart disease, or heart failure.^{22–24} However, Core Cardiology Training Statement guidelines are brief in comparison to other topics, leaving large gaps in cardiology training and knowledge acquisition.²⁵ Mandating more structured education, development and assessment of cardio-obstetric competencies, and joint support from the American College of Obstetrics and Gynecology (ACOG), American Heart Association, American College of Cardiology, American Board of Internal Medicine, and the Accreditation Council for Graduate Medical Education are needed to ensure the establishment of adequate training. Joint recommendations with specialty groups outside of the United States would also be helpful, because working groups within the European Society of Cardiology have also recommended training in CVD in pregnancy.²⁶

Aside from formal graduate medical education training models, training in cardio-obstetrics is also limited, although sessions and workshops are starting to occur at the local, national, and international level. For example, at the last 3 American College of Cardiology Annual Scientific Sessions, at least 1 session was devoted to cardiac disease in pregnancy.^{27–29} Similarly, the American Heart Association has allocated similar numbers of sessions at each of its recent annual meetings.³⁰ Smaller cardio-obstetric conferences offering continuing medical education are now more prolific, and there are several online-only courses.

Several challenges remain in providing cardio-obstetric recommendations and training. Although there are well-written guidelines for managing CVD in pregnancy, they have not been jointly developed or endorsed by major cardiology societies.^{3,7,9,26} In addition, much of the data derived for these guidelines were obtained from large, multinational registries in Canada and Europe, which limits the generalizability to a US population, who has higher rates of obesity and cardiovascular risk factors. Therefore, we urge obtaining additional US-based data and the subsequent development of multisocietal cardio-obstetrics guidelines jointly endorsed by US and international CVD and obstetric societies. Establishing widely

accepted guidelines is critically important in mandating standards in care and training and will enable credentialing organizations to incorporate required knowledge-based questions in CVD fellowship examinations. At a minimum, guidelines should encourage implementation of curricula that facilitate a deeper understanding of the (1) cardiovascular pharmacotherapies in pregnancy, (2) physiologic and pathological cardiovascular changes that occur during pregnancy and beyond, (3) knowledge of basic obstetrical modes of delivery, (4) an overview of echocardiographic changes and development of pregnancy-specific normal values, and (5) case-based reviews of pregnant and postpartum patients with simple or complex CVD. If these guidelines are incorporated in Accreditation Council for Graduate Medical Education standards, American Board of Internal Medicine blueprints, and Core Cardiology Training Statement requirements (Table 1 and Figure 2), training programs would be further incentivized to support dedicated cardio-obstetric educational efforts, including developing dedicated subspecialized fellowship tracks.

ROLE OF PARTNERSHIPS IN ADVANCING CARDIO-OBSTETRIC CARE

Multidisciplinary Team–Based Care

Improving workplace competencies in cardio-obstetrics requires strong partnerships and exposure to multidisciplinary team–based care. At some institutions, this type of care formally exists in dedicated heart centers for women or informally between adult congenital heart disease and high-risk obstetric programs.³¹ Because well-run multidisciplinary teams reduce adverse cardiovascular outcomes in high-risk pregnancies, we suggest establishing formal pregnancy heart teams (PHTs) that include cardiologists with expertise in cardio-obstetrics, obstetricians, maternal-fetal medicine specialists, primary healthcare providers, obstetric anesthesiologists, neonatologists, geneticists, pharmacists, social workers, nurses, and other care team members. Depending on the complexity of CVD (Tables 2 and 3), each team member's involvement and the frequency of prenatal visits can vary. For all patients, review of medications by maternal-fetal medicine specialists, cardiologists, and pharmacists is especially important, because each specialty can balance the risks and benefits of treatments during pregnancy and lactation. Many patients should also interact with a social worker, who can streamline access to medical coverage for postpartum maternal and neonatal care.³ For patients living a large distance from a specialized high-risk delivery hospital, the PHT needs additional involvement before the third

Table 1. Current Challenges in Training and Potential Solutions

| Developing Competencies in Cardio-Obstetrics | Current Challenges | Potential Solutions |
|--|--|---|
| Designing a curriculum in cardio-obstetrics | <ul style="list-style-type: none"> No formalized training requirements in COCATS, ACGME, ACC, AHA educational statements Limited time in training to gain competencies No joint societal educational guidelines Lack of physician awareness on the link between APOs and long-term cardiovascular risk | <ul style="list-style-type: none"> Develop cardio-obstetrics multidisciplinary grand rounds and didactics into general cardiology fellowship training Develop “intensive sessions” at national meetings addressing cardiac physiology, imaging, pathology, modified WHO ACHD risk scores, and pharmacotherapies in pregnancy Increase PHT clinical exposure |
| Increasing cardio-obstetric research | <ul style="list-style-type: none"> Limited governmental and industry research funding Limited national and international collaborations Few registries recording maternal and fetal cardiovascular outcomes Limited knowledge of the relationship between APOs and cardiovascular outcomes Limited research supporting APO incorporation in cardiovascular risk scores Lack of knowledge on interventions that prevent cardiovascular events in patients with APOs | <ul style="list-style-type: none"> Increase institutional and national grants (eg, NIH, AHA, Preeclampsia Foundation) Increase collaborations with tertiary care centers that have dedicated ACHD, high-risk obstetrics, and inherited heart disease programs Develop larger registries reflective of the US population Design registries to facilitate research and QI initiatives Increase publications in major scientific journals |
| Gaining institutional support to start a cardio-obstetric service line | <ul style="list-style-type: none"> Time constraints limiting the development of new clinical initiatives Lack of institutional financial support Limited personnel availability, especially for advanced practice providers and cardiologists specializing in cardio-obstetrics or in ACHD | <ul style="list-style-type: none"> Increase hospital departmental collaborations, especially between MFM/obstetrics, medicine, and anesthesia Encourage institutions to recognizing program building and QI programs as academic promotional criteria |
| Increasing community engagement and social support | <ul style="list-style-type: none"> Lack of awareness among pregnant patients on their cardiovascular risk factors Limited appreciation of health disparities and poor pregnancy outcomes in racial and ethnic minorities | <ul style="list-style-type: none"> Invest in community-based and SoMe outreach programs |

ACC indicates American College of Cardiology; ACGME, Accreditation Council for Graduate Medical Education; ACHD, adult congenital heart disease; AHA, American Heart Association; APO, adverse pregnancy outcome; COCATS, Core Cardiology Training Statement; MFM, maternal-fetal medicine; NIH, National Institutes of Health; PHT, pregnancy heart team; QI, quality improvement; SoMe, social media; and WHO, World Health Organization.

trimester, with detailed antepartum care and delivery plans developed to avoid inadvertent unplanned delivery at a hospital with fewer resources or physicians.



Figure 2. Improving cardiovascular workforce competencies in cardio-obstetrics.

PHTs should also focus on quality improvement (QI) initiatives for their entire cohort of pregnant patients, which can be incorporated at routine monthly multidisciplinary meetings. Other QI initiatives could be developed during meetings with stakeholders, such as community caregivers, health advocates, and health system administrators. In addition, PHT members can share QI initiatives with other institutions, especially if they participate in well-run state maternal mortality review committees.

Well-developed PHTs are also essential in providing trainees an immersive cardio-obstetrics educational experience. PHTs can help facilitate outpatient cardio-obstetrics clinic experiences for general CVD fellows, especially because these experiences are less time intensive. In addition, these teams can offer specialized inpatient rotations on labor and delivery teams for advanced trainees, who have fewer time constraints. Both types of experiences will facilitate greater encounters with women with heart disease who are considering pregnancy or are pregnant. In addition, there would be more opportunities to witness the effect of APOs on long-term cardiovascular outcomes. Finally, there will be increased occasions to discuss CVDs with different presentations in women, including coronary artery disease, pulmonary hypertension, spontaneous coronary artery

Table 2. Suggested Timetable for Involvement of the Pregnancy Heart Team During Prepregnancy, Antenatal, Labor and Delivery, and Postnatal Time Periods for Patients With Cardio-Obstetric Conditions

| Variable | HDP | GDM | CAD | Cardiomyopathy | ACHD-Modified WHO Category | | |
|--|-----|-----|-----|----------------|----------------------------|-----|------|
| | | | | | I* | II† | III‡ |
| Prepregnancy consultation | +/- | +/- | + | + | + | + | + |
| Pregnancy heart team consultation/ counseling during antenatal care | + | + | + | + | | + | + |
| Delivery at tertiary care center (level III maternal care capability facility§) | +/- | | + | + | +/- | +/- | + |
| Long-term follow-up by cardiovascular specialist | +/- | +/- | + | + | + | + | + |

ACHD indicates adult congenital heart disease; CAD, coronary artery disease; GDM, gestational diabetes mellitus; HDP, hypertensive disorders of pregnancy; and WHO, World Health Organization; +, needed; -, not needed.

*ACHD-modified WHO category I: Simple disease, such as small atrial septal defects or repaired ductus arteriosus.

†ACHD-modified WHO category II: Moderate complexity disease, such as ostium primum atrial septal defects or repaired tetralogy of Fallot.

‡ACHD-modified WHO category III: Great complexity disease, including transposition of the great arteries, mitral atresia, or single-ventricle physiological features.

§Level III maternal care capability facilities are able to provide care for complex medical conditions, obstetrical complications, and fetal conditions.

dissection, valvular disease, cardiomyopathies, familial hypercholesterolemia, and coronary microvascular dysfunction.

Research

Despite the increasing number of pregnant women with preexisting CVD and the greater awareness associating APOs with increased short- and long-term risks, few resources are directed at addressing pathogenic factors, developing effective treatments, and creating research and QI initiatives. In particular, more efforts are needed to determine the risk factors, epidemiological features, and pathogenesis of APO-related cardiac dysfunction because this could guide efforts to prevent and effectively treat subsequent CVD. In addition, there is a need for a large US-based

multicenter registry collecting CVD management data before, during, and after pregnancy.³² We suggest modeling this type of large national registry on the basis of the CMQCC (California Maternal Quality Care Collaborative) registry, which tracks data for all births in that state.³³ If created, this type of registry can guide PHT members in determining current practices and outcomes and help shape management protocols to preserve cardiovascular health. Furthermore, it can record outcomes of future pregnancies and corresponding neonatal health into early childhood.³² In addition, a large-inclusive registry can be immensely useful for QI initiatives that can identify and address disparities in maternal and postpartum morbidity and mortality, which could then focus on hospitals with better outcomes to identify and champion best practices.³³ This is particularly important for black women,

Table 3. Suggested Involvement of Pregnancy Heart Team Members for Patients With Cardio-Obstetric Conditions*

| Variable | HDP | GDM | CAD | Cardiomyopathy | ACHD-Modified WHO Category | | |
|---------------------------------|-----|-----|-----|----------------|----------------------------|-----|------|
| | | | | | I† | II‡ | III§ |
| Cardiologist¶ | + | | + | + | +/- | + | + |
| Cardiologist subspecialist¶ | - | - | + | + | - | - | + |
| Obstetrician | + | + | + | + | + | + | + |
| Maternal-fetal medicine# | + | + | + | + | + | + | + |
| Obstetric anesthesiologist | + | + | + | + | | | + |
| Pharmacist | + | | + | + | | | + |
| Primary care physician/provider | | | + | | | | |
| Geneticist** | | | | | | | |
| Social worker | + | + | + | | | | |

Modified WHO: category I, II, III, and IV, cardiomyopathy, HDP, GDM, and ischemic heart disease. Consultation as needed. Members with expertise identified and involved in multidisciplinary case reviews. ACHD indicates adult congenital heart disease; CAD, coronary artery disease; GDM, gestational diabetes mellitus; HDP, hypertensive disorders of pregnancy; and WHO, World Health Organization.

*Subspecialists for ACHD, aortopathy, heart failure, pulmonary hypertension, cardiac imaging, cardiac surgery, and interventional cardiology would be ad hoc members depending on the cardiac disease.

†ACHD Modified WHO Category I: Simple disease, such as small atrial septal defects or repaired ductus arteriosus.

‡ACHD Modified WHO Category II: Moderate complexity disease, such as ostium primum atrial septal defects or repaired tetralogy of Fallot.

§ACHD Modified WHO Category III: Great complexity disease, including transposition of the great arteries, mitral atresia, or single ventricle physiology.

who have much higher adverse outcomes, especially for those aged >39 years.¹ Finally, research and QI efforts are also critical for women who are farther from pregnancy, because the optimal timing for CVD surveillance, risk stratification, pharmacological management, and follow-up remains unknown.¹⁰

Role of Professional Societies and Stakeholder Partnerships

Professional societies are instrumental in the widespread dissemination of knowledge because they develop and distribute guidelines and educational programs. Guidelines now exist for the management of CVD in pregnancy.^{3,7} Also, recent guidelines for CVD risk assessment include preeclampsia and premature menopause as risk enhancers.¹⁹ However, none of these guidelines is jointly endorsed by major obstetric and cardiovascular societies, and none addresses short- or long-term CVD complications for patients who develop APOs. Multiple societies, including the American Heart Association, American College of Cardiology, and ACOG, should develop collaborations and guidelines that clinicians can use to care for the short- and long-term CVD needs of pregnant women.³⁴ These efforts can expand on joint statements by ACOG and American Heart Association that have stressed the importance of well-woman visits to screen, counsel, and educate women on heart health and timely recognition of APOs.⁸ They should also build on recent ACOG efforts, which formed a task force focused on CVD in pregnancy that provides comprehensive recommendations and supplements previous practice bulletins that address hypertensive disorders of pregnancy and gestational diabetes mellitus.^{35–37} They can champion the national efforts of the Alliance for Innovation on Maternal Health, which is a national coalition endorsed by ACOG focused on reducing maternal mortality by encouraging systematic implementation of maternal safety bundles.³⁸

Advocacy

Enhancing cardio-obstetrics care requires health policies that improve structural supports for pregnant women. In particular, cardiologists need to be more involved, seeking out collaborations with obstetricians, professional societies, patient support groups, health-care institutions, and health policy makers. They can build on recent successful advocacy efforts, such as the Indiana-based OB Navigators program, which provides newly pregnant high-risk women with a navigator who makes home visits and guides them during pregnancy and the first postpartum year. This type of pilot program can be encouraged and propagated in other states to increase coordination of care and address CVD and its risk factors. Other advocacy efforts should

include championing patient support organizations, which often have trustworthy peer-support structures and are intrinsically motivated to improve care. As an example, the Preeclampsia Foundation supports a community of pregnant and postpartum women and their partners, and shares information about the effects of preeclampsia on short- and long-term cardiac outcomes with interested health professionals, governmental officials, and the public.³⁹ Notably, this group is also involved in advocacy, spearheading a grassroots campaign to support bipartisan legislation, such as the Preventing Maternal Deaths Act of 2017, H.R 1318, 115TH Congress, and the Maternal Health Accountability Act of 2017, S.1112, 115TH Congress.

Social Media Platforms

Social media can increase the dissemination of guidelines, best practices, and research publications. In the cardio-obstetrics world, social media has started to connect varied interested clinicians and researchers with key stakeholders, such as policy makers, medical societies, patient-advocacy foundations, and other members of the public.⁴⁰ For example, multiple organizations, including ACOG, National Institutes of Health, Centers for Disease Control and Prevention, and other foundations, have shared late-breaking information on Twitter using the hashtag #PregnancyCardioHealth. Building on these past efforts, we encourage raising awareness in cardio-obstetrics using social media and making it a core part of their communication strategy.

CONCLUSIONS

There is growing interest in cardio-obstetrics because of the well-described manifestations of CVD during pregnancy and because there is increased awareness that APOs are associated with subsequent CVD events. It is time to increase the numbers of practitioners in cardio-obstetrics and to increase the amount of training and knowledge in this field. It is especially important to incorporate more cardio-obstetrics topics in general CVD-training programs and to establish formalized dedicated cardio-obstetrics tracks. In addition, institutions should establish more team-based care programs and PHTs to improve care, augment trainee education, and encourage research efforts. Professional societies and stakeholders should also help by organizing efforts to educate and advocate for the needs of this patient population through traditional methods and social media. Ultimately, by committing to all these strategies, we can ensure that our clinical practices, policies, and systems reflect our obligation to improve the cardiovascular health and well-being of mothers during pregnancy and beyond.

ARTICLE INFORMATION

Affiliations

From the Division of Cardiology, Johns Hopkins Ciccarone Center for Prevention of Cardiovascular Diseases (G.S., S.Z., E.D.M., P.O.), and Division of Maternal-Fetal Medicine, Department of Gynecology and Obstetrics (A.J.V.), Johns Hopkins University School of Medicine, Baltimore, MD; Division of Cardiology, Corrigan Minehan Heart Center, Massachusetts General Hospital, Harvard Medical School, Boston, MA (A.B.B.); Division of Cardiology, Department of Medicine, Emory School of Medicine, Atlanta, GA (G.P.L.); Department of Obstetrics and Gynecology, Saint Luke's Hospital, Kansas City, MO (K.L.F.); and Division of Cardiology, Department of Medicine, The Ohio State University Wexner Medical Center, Columbus, OH (L.M.).

Disclosures

None.

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