Primary Care–Based Cardiovascular Disease Risk Management After Adverse Pregnancy Outcomes: a Narrative Review

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Several common adverse pregnancy outcomes can reveal subclinical or latent cardiovascular disease (CVD) risk, transiently exposed through the physiologic stress of pregnancy. The year after pregnancy may be a singular opportunity to identify and initiate treatment for CVD risk, even before the onset of traditional CVD risk factors. However, clinical guidance regarding CVD risk management after adverse pregnancy outcomes is lacking. We therefore conducted a systematic review of US clinical practice guidelines and professional society recommendations to inform primary care–based CVD risk management after adverse pregnancy outcomes. We identified 13 relevant publications. While most recommendations were based on limited or weak evidence, we identified several areas of consensus. First, individuals with an adverse pregnancy outcome associated with future CVD are likely to benefit from CVD risk assessment—accompanied by education, counseling, and support for lifestyle modification—beginning within the first postpartum year. Second, among clinicians, clear and consistent documentation about adverse pregnancy outcomes and recommended follow-up is important to coordinate care after pregnancy. In addition, patients need to be informed about their pregnancy complications and associated CVD risks, so that they can make informed health care and lifestyle decisions. Finally, in general, CVD prevention in the year after an adverse pregnancy outcome focuses on lifestyle modification, reserving pharmacotherapy for the highest-risk patients and those with traditional CVD risk factors. While postpartum lifestyle interventions show promise for reducing CVD risk after adverse pregnancy outcomes, continued research to determine the optimal content, timing, and long-term effects of such interventions is needed.

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SAMPLE CASE PRESENTATION *A previously healthy 40-year-old G1P0 had an uncomplicated vaginal delivery at 38 1/7 weeks gestation. The pregnancy had been complicated by preeclampsia, diagnosed by elevated blood pressures and proteinuria in the 3rd trimester, for which she was monitored and had a planned induction. Her blood pressure normalized after delivery and continued to be normal at her 1- and 6-week postpartum obstetric visits. She was advised to follow up in primary care in 1 year. At her primary care visit at 1 year postpartum, she felt well and her blood pressure was normal. She was overweight (body mass index 28.1 kg/m^2), with a weight that was still above her prepregnancy baseline but reduced since delivery. No further testing was done. Her primary care clinician recommended "annual check-ups" without further explanation. Busy with work and family, the patient did not schedule a follow-up. Over the next few years, she rarely found time for exercise and adopted a diet dominated by cereal and mac'n' cheese (her child's favorite foods). Eight years later, at 48 years of age, she had an episode of chest pain while running to catch the bus. She contacted the clinic to re-establish care. Her primary care clinician diagnosed her with obesity, hypertension, prediabetes, and hyperlipidemia and referred her for an exercise stress test to evaluate her chest pain. She was subsequently diagnosed with significant non-obstructive atherosclerosis.*

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INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death among women.[1] An increasing body of evidence indicates that several common adverse pregnancy outcomes (APOs) may be important signals of CVD risk among women.[1–4] The most common such APOs are hypertensive disorders of pregnancy, gestational diabetes, and preterm delivery, each affecting ~10% of pregnancies and associated with a doubling or more of 10-year CVD risk[1–4] (detailed descriptions in Table 1[3–14]). Despite the connections between APOs and future CVD, only half of patients see a primary care clinician (PCC) in the year after an APO,[15,16] and even fewer receive CVD risk counseling informed by their pregnancy history.[17,18] Missed opportunities to respond to CVD risk after pregnancy likely contribute to sex-based disparities in CVD diagnosis, management, and outcomes.[19]

The year after pregnancy may be a critical time to identify and intervene on CVD risk. First, APOs portend the development of traditional CVD risk factors (e.g., hypertension, obesity, and dyslipidemia),[2,20] which can

Table 1 Definitions and Epidemiology of Selected Adverse Pregnancy Outcomes Associated with Future CVD

Adverse pregnancy outcomes	Diagnostic criteria	Prevalence	CVD associations[3–4]*
Preterm delivery (PTD)†	Delivery at <37 weeks' gestation[10]	• 6–12% of pregnancies worldwide[10] • Higher prevalence in Black populations[12]	1.5–2-fold increased risk of composite CVD, IHD, and stroke
Hypertensive disorders of pregnancy (HDP)	Elevated blood pressures (≥140/≥90 mm Hg on 2 occasions at least 4 h apart) during pregnancy	10% of pregnancies[5–6]	
	• Preeclampsia: HDP with thrombocytopenia, impaired liver function, new renal insufficiency, pulmonary edema, or new-onset cerebral, or visual disturbances *• Eclampsia: a severe complication of preeclampsia, resulting in seizures*	*• 3–7% of pregnancies[10–11]* *• 25% increased prevalence between 1987 and 2004[7]* *• Higher prevalence in Black populations[9] and among patients with obesity, diabetes, preexisting hypertension, advanced reproductive age, and primiparity[10]*	*• 1.5–3-fold increased risk of composite CVD, IHD, and stroke* *• 2–4-fold increased risk of heart failure,[13–14] higher if recurrent[13]*
	• Gestational hypertension: HDP with onset after 20 weeks of gestation, not meeting criteria for preeclampsia/eclampsia	*• 6–7% of pregnancies[11]*	*1.5–2-fold increased risk of composite CVD, IHD, and stroke*
Gestational diabetes (GDM)	• Diabetes with onset during pregnancy • Usually detected through universal screening at 24–28 weeks' gestation (or first prenatal visit if high risk), then diagnosed by 3-h 100-g OGTT with ≥2 blood glucose levels above the following thresholds: o Fasting: 95 mg/dL o 1h: 180 mg/dL o 2h: 155 mg/dL o 3h: 140 mg/dL	• 5–10% of pregnancies[10] • Higher prevalence in Black,[5,8] Hispanic, Native American, and Asian or Pacific Islander populations[8]	1.5–2-fold increased risk of composite CVD and IHD; 1.3-fold increased risk for stroke

Abbreviations: CVD, cardiovascular disease; HDP, hypertensive disorders of pregnancy; IHD, ischemic heart disease; OGTT, oral glucose tolerance test
**Based on umbrella review with average follow-up period of 7–10 years[3]*
†Note: full term is defined as ≥39 weeks' gestation

appear within the year after pregnancy[21,22] and are key drivers of long-term CVD risk.[23] Timely follow-up after APOs may be able to prevent, diagnose, and manage traditional CVD risk factors. Second, the US reproductive-age population has low levels of preventive health care use, with the notable exception of during pregnancy.[24] Pregnancy is therefore an important potential gateway to primary care, especially for those at increased risk for future disease. Third, the year after pregnancy is a "teachable window" when patients may be more motivated than usual to pursue healthy lifestyle changes.[25] Finally, postpartum CVD risk management may be beneficial for future pregnancy outcomes.[26,27]

PCCs are well positioned but often poorly equipped to intervene on the pathway between APOs and future CVD.[28] Studies suggest that most general internists do not routinely incorporate pregnancy history into CVD risk counseling.[18] In addition, practical guidance for PCCs is lacking on how to assess and manage CVD risk among individuals with recent APOs. To address these knowledge gaps, we conducted a review of clinical practice guidelines and professional society recommendations to inform primary care–based CVD risk management in the year after an APO.

METHODS

We systematically searched 3 databases (PubMed, EMBASE, and CINAHL) and 9 clinical websites (Guideline Central, American College of Obstetricians and Gynecologists [ACOG], US Preventive Services Task Force [USPSTF], American Academy of Family Physicians [AAFP], American College of Physicians [ACP], Society of General Internal Medicine [SGIM], American Diabetes Association [ADA], and the American Heart Association[AHA], and American College of Cardiology [ACC]), Google, and Google Scholar for clinical practice guidelines, society recommendations, or consensus statements[29] related to postpartum care in the USA, published in 2010 through 2020 (Appendix Table 1 in the supplementary information). Two authors (MMH, and MAF or CAP) independently conducted title and abstract screening followed by full-text review for recommendations relevant to primary care during the year after an APO. We excluded postpartum care recommendations up to and including the comprehensive postpartum visit (which usually takes place around 6 weeks after delivery), when most patients are still under the care of their obstetric care clinician, unless the PCC was specifically mentioned as the responsible clinician. We also excluded recommendations specific to patients with known prepregnancy CVD risk factors (e.g., chronic

hypertension) in order to maintain the focus of the paper on CVD risk potentially revealed by an APO. A third author (CAP or MAF) resolved discrepancies. If multiple versions of a publication were available, only the most recent version was included. If an eligible publication was identified during the review of other articles, it was also included (n=4[30–33]). Of 1084 unique results, 35 articles underwent full-text review, and 13 articles were included (Appendix Figure 1 in the supplementary information).

The included publications used various recommendation grading systems and often provided ungraded recommendations; 1 included only ungraded recommendations.[34] In order to standardize and synthesize the data, we converted all recommendation grades, where available, into the USPSTF format given its relative simplicity, high prevalence of use among the included publications, and familiarity with PCCs (Appendix Table 2 in the supplementary information). USPSTF grade "A" indicated services that should be offered or provided (high certainty of substantial net benefit); "B," services that should be offered or provided (high certainty of moderate benefit or moderate certainty of substantial benefit); and "C," services that should be selectively offered or provided (at least moderate certainty of small net benefit).[35]

We recognize that pregnancy is possible in people of all genders. However, for the purposes of transparency, we have made minimal changes to the original language of the existing recommendations, many of which use gender-specific terms (e.g., she/her, woman/women, maternal).

RESULTS

We identified 13 US guideline or society recommendation publications with clinical guidance relevant to primary care–based CVD risk management during the year after an APO (Table 2).[5–8,30–34,36–39] The AHA was the first to incorporate APOs into CVD risk management guidelines in 2011. Clinical practice recommendations regarding APOs and CVD risk accumulated at an increasing rate thereafter; two-thirds were published in 2018 or later. Many publications focused on care during pregnancy but included some postpartum recommendations;[5,7,8,36,39] only 3 were specific to postpartum or interpregnancy care.[6,34,38]

We organized care recommendations by APO (Figure 1; see Appendix Table 3 in the supplementary information for detail). Key recommendations regarding CVD risk and supporting evidence are reviewed in the text below and synthesized into a practical guide for PCCs (Figure 2).

All Parous Patients

Four publications recommended screening all parous patients for APOs (*B*)[37] (*C*)[5] (*ungraded*),[30,32] ideally starting within the first year postpartum (*B*)[37] (*C*).[5] The publications varied in terms of APOs discussed and strength of recommendations. The strongest screening recommendation came from the AHA/ASA and applied to a history of preeclampsia/eclampsia as revealing of stroke risk (*B*),[37] based on numerous cohort studies and meta-analyses demonstrating significant associations of preeclampsia/eclampsia with stroke and other CVD outcomes across the lifespan.

Any or Unspecified Adverse Pregnancy Outcome

For patients with any identified APO, 2 publications recommended "comprehensive CVD risk assessment" within 3 months postpartum (*ungraded*; see Figures 1 and 2 for details).[5,34] The recommendations for CVD risk assessment within 3 months postpartum appeared to be based on expert opinion or best practices; no specific trials or cohort studies were cited.

For postpartum CVD risk management, lifestyle-based interventions were emphasized (*C*)[5,30] (*ungraded*),[32] and pharmacotherapy was reserved for patients with high CVD risk (*ungraded*)[5,30,32] or persistent CVD risk factors after at least 6 months of lifestyle modification (*ungraded*).[5] A specific lifestyle recommendation for postpartum patients was breastfeeding (*A*)[38] (*ungraded*).[5,39] Support for breastfeeding was based on multiple observational studies associating longer durations of breastfeeding with reduced risks for chronic diseases such as diabetes,[38,39] hypertension,[5,38] and CVD[5](specifically myocardial infarction[38]). Diet and exercise were also recommended for postpartum weight loss (*ungraded*),[38,6] yet evidence on the most effective means of weight loss was lacking.[38]

Clinicians were advised to consider a history of APOs in discussions about lifestyle interventions and the potential benefits of statin therapy (*B*)[32] (*C*).[33] A number of APOs (e.g., hypertensive disorders of pregnancy, gestational diabetes, preterm delivery, and giving birth to a small-for-gestational-age infant) were identified as "risk-enhancing factors," which may favor initiation or intensification of statin therapy among adults 40–75 years of age with borderline risk (5 to <7.5% 10-year risk) (*C*) or intermediate risk (7.5 to <20% 10-year risk) (*B*) for atherosclerotic CVD.[32] For individuals with the potential to become pregnant and taking statins (or other potential teratogens, e.g., ACE inhibitors or ARBs[38]), a "reliable form of contraception" was recommended (*C*).[32] Clinicians were also advised to review medications and discontinue potential teratogens prior to a subsequent pregnancy (*A*).[38]

In addition, for individuals at risk of CVD, "ongoing collaborative care" between primary and obstetric care clinicians or cardiologists was suggested (*ungraded*).[5] While lifelong CVD prevention was promoted (*ungraded*),[5,34] shared decision-making around the relative value, costs, and convenience of ongoing CVD risk assessments was advised (*ungraded*),[5,34] given that the optimal timing of ongoing risk assessments is unknown.[5] Patient education and empowerment was also a recurrent theme (*ungraded*),[5,34] especially in light of the fact that postpartum care is often fragmented such

Table 2 Overview of clinical practice guidelines for primary care in the year after an adverse pregnancy outcome associated with future CVD, U.S. 2010-2020

Publications meeting inclusion criteria													
	Effective-ness-based Guidelines for the Prevention of Cardiovasc-ular Disease in Women[30]	Diabetes and Pregnancy[36]	Hyperten-sion in Pregnancy[31]	Guidelines for the Prevention of Stroke in Women[37]	Gestational Diabetes Mellitus[8]	Optimizing Postpartum Care[34]	Pregnancy and Heart Disease[5]	Interpregna ncy care[38]	Guideline on the Management of Blood Cholesterol[32]	Guideline on the Primary Prevention of Cardiovasc-ular Disease[33]	Postpartum Care: An Approach to the Fourth Trimester[6]	Manage-ment of Diabetes in Pregnancy: Standards of Medical Care in Diabetes—2020[39]	Gestational Hyperten-sion and Preeclamp-sia[7]
Sponsoring organization (publication type)	AHA (guideline)	ES (guideline)	ACOG (guideline)	AHA/ASA (guideline)	ACOG (practice bulletin)	ACOG (committee opinion)	ACOG (practice bulletin)	ACOG, SMFM (consensus statement)	ACC/AHA and others* (clinical practice guideline)	ACC/AHA	AAFP (recommend ations)	ADA (guideline)	ACOG (practice bulletin)
Year	2011	2013 Nov	2013 Nov	2014	2018 Feb	2018 May	2019	2019 Jan	2019 Jun	2019 Sep	2019 Oct	2020 Jan	2020 Jun
Intended audience	n/s	n/s	n/s	n/s	n/s	OB-GYNs, other OCCs, and PCCs	n/s	OB-GYNs and other HCCs	n/s	n/s	Family physicians	n/s	n/s
Postpartum focus	No	No	No	No	No	Yes (0-12 weeks)	No	Yes (inter-pregnancy)	No	No	Yes (0-12 weeks)	No	No
Adverse pregnancy outcomes addressed													
Any or unspecified	X			X		X	X	X	X	X	X		
Preterm delivery			X†	X		X	X	X	X	X			
Hypertensive disorders of pregnancy			X†	X‡		X	X	X	X	X‡	X		X
Gestational diabetes		X			X	X	X	X	X		X	X	

Abbreviations: AAFP, American Academy of Family Physicians; ACC, American College of Cardiology; ACOG, American College of Obstetricians and Gynecologists; ADA, American Diabetes Association; AHA, American Heart Association; ASA, American Stroke Association; CVD, cardiovascular disease; ES, Endocrine Society; GDM, gestational diabetes; HCCs, health care clinicians; n/s, not specified; OB-GYNs, obstetrician-gynecologists; OCCs, obstetric care clinicians; PCCs, primary care clinicians; SMFM, Society for Maternal-Fetal Medicine

* In addition to the ACC and AHA, written and approved by representatives from: American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), American Academy of Physician Assistants (AAPA), Association of Black Cardiologists (ABC), American College of Preventive Medicine (ACPM), American Diabetes Association (ADA), American Geriatrics Society (AGS), American Pharmacists Association (APhA), American Society for Preventive Cardiology (ASPC), National Lipid Association (NLA), and Preventive Cardiovascular Nurses Association (PCNA)

† Preterm delivery with preeclampsia, or recurrent preeclampsia, only

‡ Preeclampsia only

ALL POSTPARTUM PATIENTS

Within 1 year postpartum

☐ Screen for adverse pregnancy outcomes associated with future CVD: history of pre-eclampsia/eclampsia (B)[37] (C)[5] (U)[30,32]; hypertensive disorders of pregnancy (C)[5] (U)[32]; intrauterine growth restriction, idiopathic preterm delivery, placental abruption (C)[5]; gestational diabetes (C)[5] (U)[30,32]; preterm delivery or giving birth to small-for-gestational-age newborn (U)[30,32]

☐ Document pregnancy history in the medical record (U)[34,38]

☐ Ensure recommendations are documented in medical record, provided to patient, and communicated to care team (U)[5,34]

Counseling

☐ Encourage breastfeeding now and in future pregnancies (A)[38] (U)[5,37]

☐ Encourage regular aerobic activity, including among those who are lactating (U)[34]

☐ Provide family planning counseling, including recommendations for birth spacing >6 months (B)[38], ideally >18 months (B)[38]

During interpregnancy care

☐ Review medications and discontinue potential teratogens prior to next pregnancy (A)[38]

☐ *For patients with low health literacy, no or limited English proficiency, or other communication needs*: Consider patient navigators, trained medical interpreters, health educators, and *promotoras* to facilitate quality care (C)[38]

ANY ADVERSE PREGNANCY OUTCOME*

Within 12 weeks postpartum

☐ Conduct comprehensive CVD risk assessment (U)[5,34], paying particular attention to the effect of social determinants of health (U)[34]

Detailed medical hx (smoking; physical activity; breastfeeding; hx of hypertension, diabetes, or CVD; 1st degree family hx of CVD, hypertension, or diabetes), postpartum medication monitoring, physical exam (resting BP and heart rate; BMI and waist circumference), and biochemical testing (chol/lipid profile; FBG (or OGTT if hx of gestational diabetes); urine protein assessment (Prot:Cr ratio); nutrition assessment (U)[5]

☐ Counsel on identified risk factors (U)[5]

☐ *For low/moderate CVD risk (<10% 10-year risk):* focus on Class I lifestyle recommendations† (B)[37] (U)[5,30]

☐ *For high CVD risk (≥10% 10-year risk):* implement Class I lifestyle recommendations* (B)[37] and consider Class II recommendations‡ (U)[5,30]

After 6 months to 1 year of lifestyle modification

☐ Repeat tests for borderline or elevated BP or lipid abnormalities; if persistently elevated, consider pharmacologic treatment (U)[5]

☐ *For patients aged ≥40y with borderline (5% to <7.5%) or intermediate (7.5% to <20%) 10-year CVD risk:* Consider APO hx as a risk-enhancing factor (U)[33], which may favor initiation or intensification of statin therapy for those with borderline (C)[32] or intermediate risk (B)[32]

Counseling

☐ Counsel patients on associations between their pregnancy complication(s) and higher lifetime risk of maternal cardiometabolic disease (U)[5], especially those with high risk of CVD (C)[5]

☐ Discuss need for **annual** CVD risk assessment and lifetime CVD prevention (U)[5,34]

☐ Consider APO hx when discussing lifestyle interventions and the potential for benefit of statin therapy (B)[32] among other prevention interventions (C)[33]

☐ Educate patients and engage them in shared decision-making (U)[5] with regard to their individual CVD risks (U)[5]

☐ In family planning, incorporate patients' future pregnancy desires, personal preferences, underlying disease, and relative risks and benefits of the contraceptive option considered (C)[5]

☐ *For patients with high CVD risk:* intrauterine devices are the preferred non-permanent contraceptive option (C)[5]

☐ *For patients with stroke risk factors:* oral [estrogen-containing] contraceptives may be harmful (D)[37]; prior to initiating oral [estrogen-containing] contraception, measure blood pressure (B)[37] and consider aggressive therapy of stroke risk factors (C)[37]; do not screen for prothrombotic mutations (D)[37]

☐ *For patients on statins [or other potential teratogens, e.g., ACE-inhibitors or ARBs], who are sexually active and of childbearing age:* counsel to use a reliable form of contraception (C)[32]

Strength and quality of recommendation indicated by USPSTF grades (A, strong; B, moderate; C, weak; and U, ungraded). **Bold** text indicates recommended timeframe.

Abbreviations: ACE-inhibitors, angiotensin converting enzyme-inhibitors; APO, adverse pregnancy outcome; ARBs, angiotensin receptor blockers; BMI, body mass index; BP, blood pressure; CVD, cardiovascular disease; FBG, fasting blood glucose; hx, history; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; NSAIDs, non-steroidal anti-inflammatory drugs; OGTT, oral glucose tolerance test; PCC, primary care clinician; SGA, small for gestational age; T2DM, type 2 diabetes

* Specified APOs: hypertensive disorders of pregnancy and gestational diabetes;[5,34] preterm delivery;[34] intrauterine growth restriction, idiopathic preterm birth, placental abruption, and excessive gestational weight gain/postpartum weight retention[5]

† Class I recommendations: BP control, LDL-C-lowering therapy (goal <100 mg/dL), beta-blocker, ACE-inhibitor/ARB

‡ Class II: LDL-C-lowering therapy (goal <70 mg/dL if very high-risk), non-HDL-C-lowering therapy (goal <130 mg/dL if very high-risk with recent ACS or multiple poorly controlled risk factors), glycemic control, aspirin/antiplatelet agents, omega-3 fatty acids

§ Test options include annual HbA1c or FPG, or triennial 75g OGTT using nonpregnant thresholds (B)[39]

PRETERM DELIVERY

Counseling

☐ Counsel on higher lifetime risk of maternal cardiometabolic disease (U)[34], especially in cases of idiopathic preterm delivery[5]

During interpregnancy care

☐ Emphasize birth spacing recommendations of >6 months and ideally >18 months (B)[38]

☐ Review current recommendations to reduce risk of recurrent preterm delivery (U)[34]; currently there is insufficient evidence to screen for or treat asymptomatic genitourinary infections (B)[38]

HYPERTENSIVE DISORDERS OF PREGNANCY

Recommended visit with PCC or cardiologist at 7-10 days postpartum

During 12 weeks postpartum

☐ Evaluate BP for resolution of hypertension, with goal BP <120/80 mm Hg (U)[38]

☐ *For BP ≥150/100 mm Hg:* treat; can use oral nifedipine or labetalol (U)[6]

☐ *For BP ≥160/110 mm Hg:* hospitalize (U)[6]

☐ *For signs of end-organ damage:* hospitalize (U)[6]

☐ Continue to use NSAIDs preferentially over opioid analgesics (A)[7] (U)[6]

Within 1 year postpartum

☐ Document history of preeclampsia as risk factor for hypertension and stroke (C)[37]

☐ Evaluate and treat for CVD risk factors including hypertension, obesity, smoking, and dyslipidemia (C)[37]

Counseling

☐ Counsel that HDP is associated with higher lifetime risk of maternal cardiometabolic disease (U)[34]

☐ Recommend lifestyle changes to manage CVD risk factors, such as achieving healthy weight (U)[6-7,38]

☐ Recommend annual follow-up of BP and body weight monitoring (U)[6]

☐ *For patients with preterm delivery:* discuss suggested annual assessment of BP, FBG, and BMI; health care clinicians and patients should make this decision based on their judgment of the relative value of extra information versus expense and inconvenience (C)[31]

☐ Convey information using proven health communication practices, such as nonmedical language, clear and slow speech, pictures, feedback (C)[31]

During interpregnancy care

☐ Review current recommendations to reduce risk of recurrent preeclampsia, such as aspirin (U)[34]; consider low-dose aspirin in any future pregnancy (U)[5,38]

☐ *For patients with early-onset preeclampsia and early preterm delivery, or recurrent preeclampsia:* discuss benefits of low-dose aspirin beginning in the late first trimester to reduce incidence and morbidity of preeclampsia in future pregnancy (C)[31]

☐ Avoid or discontinue ACE-inhibitors and ARBs prior to next pregnancy (U)[38]

GESTATIONAL DIABETES

At 4-12 weeks postpartum

☐ Perform 2-hour, 75g OGTT to identify diabetes, IFG levels, or IGT (B)[36,39] (C)[6,8] (U)[34,38]; may also include a FBG (U)[8]

☐ *For normal results*: rescreen every 1-3 years or more frequently between pregnancies (C)[8,36] (U)[6,38]

☐ *For IFG or IGT*: initiate intensive lifestyle modification or medical therapy (A)[39] (C)[8] (U)[38], i.e., metformin (A)[39]; rescreen every year (C)[8]

☐ *For diabetes:* initiate preventive or medical therapy; please note, more likely to benefit from intensive medical therapy (C)[8]

During 1 year postpartum

☐ Monitor BP for the development of hypertension (U)[6]

☐ ☐ Conduct psychosocial assessment and provide support for self-care (C)[39]

Counseling

☐ Counsel that gestational diabetes is associated with higher lifetime risk of maternal cardiometabolic disease (U)[34], especially T2DM (U)[5]

☐ Counsel on the need for lifelong screening§ for diabetes or prediabetes at least every 3 years (B)[39], and especially before any future pregnancies (C)[36]

☐ Recommend lifestyle measures, such as weight loss and physical activity, to reduce risk of T2DM (C)[36] (U)[6]

☐ Recommend **annual** follow-up (U)[6]

☐ Note that women with diabetes or a history of gestational diabetes have the same contraceptive options and recommendations as other women (B)[36] (U)[39]

During interpregnancy care

☐ Recommend preconception screening for diabetes and preconception care to identify and treat hyperglycemia (C)[36,39], and early screening for gestational diabetes in the next pregnancy (U)[5]

Figure 1 Summary of clinical practice recommendations for primary care in the year after an adverse pregnancy outcome associated with future CVD

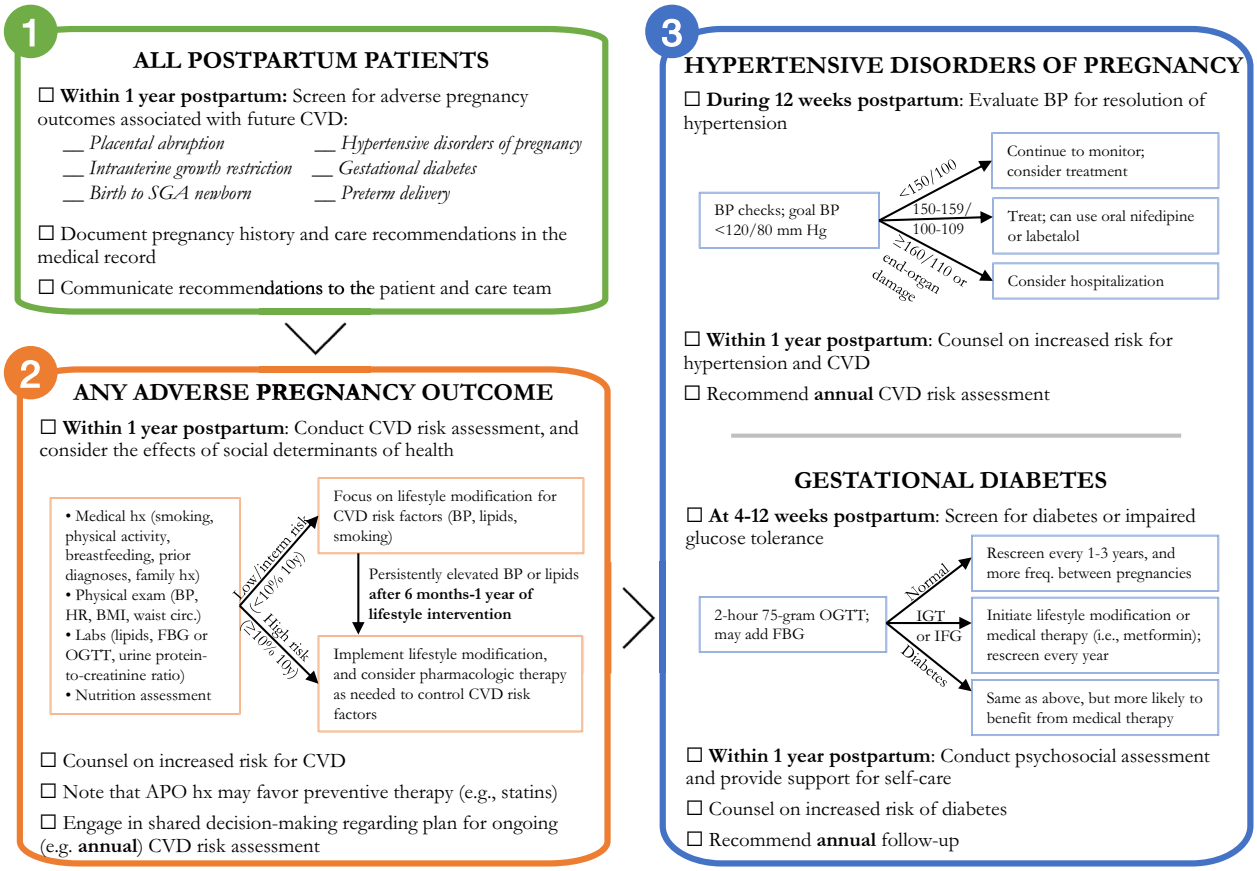

Figure 2 Practical guide to primary care in the year after an adverse pregnancy outcome associated with future CVD

that postpartum patients may have to coordinate or initiate much of their care.[5]

Hypertensive Disorders of Pregnancy

Eight publications provided recommendations specifically for patients with a recent hypertensive disorder of pregnancy.[5–7,31,32,34,37,38] Key recommendations included early postpartum follow-up with a PCC or cardiologist (*C*),[5] and—during the first 12 weeks postpartum—close monitoring to ensure resolution of hypertension (*ungraded*)[38] with aggressive treatment as needed for elevated blood pressures (*ungraded*).[6]

For individuals with both preeclampsia and preterm delivery, annual CVD risk assessment was suggested (*C*).[31] The authors of the recommendation acknowledged that because "the value and appropriate timing of assessment is not yet established," patients should be involved in shared decision-making regarding plans for ongoing CVD risk assessment.[31]

Gestational Diabetes

Seven publications provided recommendations specifically for patients with recent gestational diabetes.[5,6,8,34,36,38,39] They consistently recommended glycemic testing using a 75-g, 2-h oral glucose tolerance test postpartum (*B*)[36,39] (*C*)[6,8] (*ungraded*).[34,38] The most commonly recommended timeframe for follow-up testing was 4–12 weeks postpartum.[6,8,34,38,39] The authors of the recommendations cited consistent observations that gestational diabetes was associated with manifold increased risks of future prediabetes and diabetes.[36,39]

For individuals with prior gestational diabetes and normal postpartum glycemic testing, repeat testing was recommended every 1–3 years at least (*C*)[8,36] (*ungraded*).[6,38] For those with findings of impaired fasting glucose or impaired glucose tolerance, lifestyle modification or medical therapy (specifically metformin[39]) was recommended (*A*)[39] (*C*)[8] (*ungraded*),[38] followed by repeat testing every year (*C*).[8] The authors of the grade A recommendation[39] cited a large randomized clinical trial, in which intensive lifestyle modification was as effective as metformin at preventing progression from gestational diabetes to type 2 diabetes (35–40% lower 10-year incidence) when compared with placebo.[40] Many publications recommended counseling all individuals with prior gestational diabetes on their elevated risk for diabetes (*ungraded*)[5,34] or need for lifelong diabetes screening (*B*)[39] (*C*).[36]

DISCUSSION

In this systematic review of US clinical practice recommendations for the management of CVD risk during the year after an APO, we identified 13 relevant publications from 2010 through 2020. The AHA formally recognized APOs as indicative of CVD risk in 2011, after which we observed an increasing rate of publications addressing a growing number of APOs. Recommendations were often vague or inconsistent and based on limited evidence. We found no comprehensive guidance for general internists.

Two recent publications by the ACC/AHA state that APOs can help identify individuals at increased risk for future CVD, which can inform early preventive counseling and care.[1,2] There is now a large body of observational data supporting the associations between APOs and future CVD; in general, individuals with APOs are at least twice as likely to develop CVD over their lifetimes, when compared with individuals who have had only healthy pregnancies.[2,3] Unfortunately, evidence to guide primary care–based CVD risk management and follow-up after APOs is limited. To our knowledge, there have been no randomized controlled trials to evaluate the optimal content and timing of CVD risk follow-up after APOs. In addition, the long-term effects of interventions to reduce CVD risk after APOs are not well established.

Despite the current evidence gaps, we identified several actions that PCCs can take to address CVD risk in the first postpartum year. First, all parous patients should be screened for a history of APOs associated with CVD risk. Any identified APO should be documented in the medical record and communicated to the patient. Patients with an APO are likely to benefit from comprehensive CVD risk assessment and counseling on their individual risks, beginning within the first postpartum year. In general, lifestyle interventions are first-line for postpartum individuals with elevated CVD risk based on their APO history. Pharmacotherapy is reserved for those with persistent uncontrolled CVD risk factors; high CVD risk (≥10% 10-year risk); or borderline or intermediate CVD risk (≥5% 10-year risk) and aged 40 years or more. Hypertensive disorders of pregnancy and gestational diabetes warrant additional close monitoring after pregnancy for the development of hypertension and hyperglycemia, respectively. Team-based care is recommended for individuals at risk for CVD[5] and has been described (including the emerging field of Cardio-obstetrics[41]) in detail elsewhere.[4]

Clinical trial data suggest that lifestyle interventions may produce substantial and sustained improvements in CVD risk after APOs. The evidence is strongest for diabetes prevention after gestational diabetes. For example, in a large randomized controlled trial, individuals with impaired glycemic control and overweight were randomized to intensive lifestyle intervention, metformin, or placebo; the subgroup analysis of 350 participants with prior gestational diabetes revealed that intensive lifestyle modification reduced 10-year diabetes incidence by 35% (as effective as metformin), when compared with placebo.[40] A meta-analysis of 11 randomized controlled trials found a similar effect size for postpartum lifestyle interventions implemented within 3 years after gestational diabetes, with a 43% reduction in 10-year diabetes incidence.[42] Emerging data suggest that even brief interventions in the year after pregnancy can have sustained effects on one's CVD risk. In a randomized controlled trial of blood pressure self-management versus usual care for 6 months after hypertensive pregnancies, the intervention group had lower blood pressures,[43] a difference that persisted at 3-year follow-up.[44] In summary, postpartum lifestyle interventions may be able to delay or prevent the onset of CVD risk factors and improve CVD risk factor control, with protective effects extending for years after pregnancy.

The AHA's Life's Simple 7® summarizes key activities to promote cardiovascular health: (1) manage blood pressure, (2) control cholesterol, (3) reduce blood sugar, (4) get active, (5) eat better, (6) lose weight, and (7) stop smoking.[45] The postpartum period presents unique opportunities to achieve these goals. For instance, weight management can focus on losing weight gained recently during pregnancy, as postpartum weight retention (usually assessed at 6 months or 1 year after delivery) is associated with higher weight gain in future pregnancies, diabetes risk, and future obesity.[46] Postpartum patients can also be encouraged to continue healthy habits that they started during pregnancy, such as smoking cessation.[47,48] In addition, postpartum patients may be more motivated to adopt a healthier lifestyle for family benefit, rather than for individual benefit.[49] Interpregnancy CVD risk factor control (e.g., weight loss) also appears to be important for subsequent pregnancy outcomes[50] and offspring health.[51] Drawing connections between the patient's health and their present and future family's wellness can strengthen postpartum CVD risk counseling and management.

Data are still needed to define the optimal content and targets of postpartum CVD risk assessment and management interventions. Current recommendations focus on identifying, treating, and preventing traditional CVD risk factors (e.g., hypertension and obesity). Traditional CVD risk factors are logical targets for intervention because they occur at increased rates within a few years of complicated pregnancies,[2,20,52,53] explain most of the associations between pregnancy complications and long-term CVD risk,[23] and are present in >90% of cases of premature CVD in both men and women.[54] However, many pharmacologic mainstays of CVD risk reduction (e.g., statins, ACE inhibitors, and ARBs) are of limited use during the reproductive years, due to poor or lacking fetal safety data. Meanwhile, as described above, clinical trial data on postpartum lifestyle interventions to reduce CVD risk are limited but promising. Current recommendations emphasize lifestyle modification for all but the highest-risk postpartum patients. Continued research on behavioral approaches to CVD risk reduction after APOs—including the most effective means to support postpartum weight loss[55] and the effects of breastfeeding on maternal cardiometabolic health[56]—is essential to inform practice.

Data are also lacking on the optimal timing of postpartum CVD risk assessment and management. Current

recommendations support CVD risk assessment, counseling, and management (as needed) beginning within the first postpartum year. ACOG suggests that the ideal timing may be within 3 months postpartum.[5,34] One advantage of earlier postpartum CVD risk assessment is that it can be initiated by the obstetric care clinician (i.e., before patients transition out of pregnancy-based care and may be lost to follow-up). However, many CVD risk markers appear to be elevated for several months after pregnancy, especially among individuals with recent APOs.[57] Early postpartum CVD risk assessment may exaggerate long-term CVD risk. It may therefore be reasonable to consider postponing CVD risk assessment (with the exception of glycemic testing after gestational diabetes) until 3–6 months postpartum.[28] Ongoing CVD risk assessments are likely to be beneficial, as absolute CVD risk increases with age.

Unfortunately, recommendations for CVD risk management after APOs are often unmet in primary care. Only about half of patients with medically complicated pregnancies see a PCC during the postpartum year,[15,16] and their PCC (in particular if they are an internist) is unlikely to identify and incorporate pregnancy history into CVD risk assessment.[17,18] In addition, follow-up after APOs is unequal across society. Hypertensive disorders of pregnancy are less likely to be followed by a primary care visit among Black or Hispanic versus White patients,[15] and are twice as likely to result in a hypertensive postpartum readmission among Black versus White patients.[58] Postpartum incident CVD is 3 times as common among individuals with public versus commercial insurance.[59] Barriers to postpartum follow-up occur at many levels of the health care system, including: insurance discontinuities after pregnancy that disproportionately affect low-income people and people of color;[60] poor care coordination due to inconsistent documentation, haphazard handovers, and confusion about who is responsible for care;[61] among PCCs, inadequate training in gender-specific CVD risk assessment[62] and pregnancy-related health topics;[63] among patients, ineffective communication from their clinicians and low levels of knowledge regarding their APO-associated health risks;[49,61] and competing priorities for patients (e.g., newborn care, returning to work) as well as clinicians.[61]

Improving PCC practice is not enough to ensure optimal postpartum care; infrastructure and policy change are also required.[64,65] First and foremost, universal health insurance for the entire year after pregnancy is essential.[60] Comparisons between Medicaid expansion and non-expansion states suggest that extending the duration of postpartum health insurance leads to increased outpatient follow-up, especially after medically complicated pregnancies.[66] In addition, specialized postpartum transition clinics have been associated with improved postpartum transitions to primary care[67,68] and blood pressure management.[68] Postpartum patient navigation shows promise as another means to support continuity of care after pregnancy.[69] Clinical support tools embedded in the electronic medical record (e.g., obstetric event flags or best practice advisories) can be used to transfer knowledge and recommendations between clinicians. Web- or app-based adjuncts to in-person care may support lifestyle change after APOs,[70] by increasing patients' CVD risk knowledge and self-efficacy.[71] Virtual visits and remote blood pressure monitoring have expanded during the COVID-19 pandemic and may prove beneficial for postpartum CVD risk monitoring and management,[44,72] given the considerable logistical barriers to in-person visit attendance during the postpartum period. Finally, online resources including patient handouts, such as those developed by the ACC (https://www.cardiosmart.org/assets/infographic/heart-health-after-pregnancy), and a postpartum health record, such as that developed by the founders of the Maternal Health Clinic in Kingston, Canada[73] (https://www.themothersprogram.ca/sites/themothersprogram.ca/files/Postpartum%20Health%20Record_20AUG2019.pdf), may assist patients and their PCCs discuss and manage CVD risk after pregnancy.

CONCLUSION

Preventingpregnancy-related deaths, health inequities, and the long-term sequelae of pregnancy complications is a public health priority;[74] effective management of CVD risk after APOs is critical to these efforts. Clinical practice recommendations for primary care during the year after an APO are few, non-comprehensive, and limited by critical evidence gaps. However, they consistently emphasize the need for timely risk assessment, patient education and empowerment, and lifestyle modification to prevent CVD. PCCs caring for patients during the year after pregnancy must be able to (1) identify APOs associated with future CVD; (2) empower patients with information about their individual CVD risks and follow-up needs, informed by their reproductive history; and (3) support healthy behavior changes within the postpartum context. Further research is needed to clarify the optimal content, timing, and long-term health effects of postpartum interventions and follow-up to reduce CVD risk after APOs, both in the first postpartum year and beyond.

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