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Reproductive Health and Cardiovascular Disease (G Sharma, Section Editor)

Postpartum Hypertension and the Role of Postpartum Clinics and Digital Health

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Abstract

Purpose of review Postpartum hypertension is common, vastly underrecognized and increases the risk for future cardiovascular events. One of the most common risk factors for the development of postpartum hypertension is preexistent hypertensive disorders of pregnancy (HDP). According to Cirillo and Cohn (2015), HDP complicate 5–10% of pregnancies worldwide, and their prevalence is increasing. Unfortunately, many clinicians and patients are not aware of the risks associated with HDP, nor are they aware of the importance of monitoring blood pressure in the postpartum period. Telemedicine and digital health may improve the detection and treatment of postpartum hypertension.

Recent findings During the first year after delivery, women with HDP have a 12- to 25-fold greater risk of developing chronic hypertension (HTN), which is the most common cause for readmission. In addition to HDP, there are also secondary causes of HTN that need to be considered in the appropriate setting such as medications and endocrine and renal disorders. There is little data regarding the effectiveness of antihypertensive medications and the role of diet and exercise in the management of postpartum HTN. Early postpartum healthcare follow-up is associated with better maternal and fetal outcomes, as discussed by Goulet et al. (2007). Yet, McKinney et al. (2018) estimated that only 40% of women attend face-to-face follow-up with a healthcare provider 6 weeks after delivery. This emphasizes the need for innovative models to improve rates of follow-up and better accessibility of healthcare monitoring and intervention for postpartum women.
Summary Screening for postpartum HTN is essential. The establishment of structured follow-up incorporating postpartum clinics, whether remote or in-person, would allow monitoring of blood pressure, increasing the detection and treatment of postpartum HTN and improving its management and treatment. These visits also provide an opportunity for providers to assess and educate women about other modifiable cardiovascular risk factors with the goal of reducing their overall cardiovascular risk profile and likelihood of future cardiac events. Digital health resources and interventions are becoming readily available and more popular among mothers when compared to in-person follow-up. This is likely due to lower burden of transportation, less cost, and availability of online support. Finally, further clinical studies investigating antihypertensive medications and the effect of diet and exercise on postpartum hypertension are critical.

Introduction

Pregnancy has been described as a window to future health in women, particularly for future cardiovascular disease and death. This association is clearly seen in women who experience hypertensive disorders of pregnancy (HDP) and their risk of developing postpartum hypertension (HTN). HDP include gestational hypertension (GH), chronic hypertension, preeclampsia with and without severe features, and preeclampsia superimposed on chronic hypertension. HDP have been reported to complicate approximately 10–15% of pregnancies worldwide, and their prevalence is increasing [1]. Up to 350,000 women in the USA are diagnosed with preeclampsia every year [2], with the incidence increasing by 25% between 1987 and 2004 [3, 4]. HDP are associated with long-term cardiovascular morbidity and mortality, and these women are at a 2–4-fold increased risk of heart failure, acute coronary syndrome, and cerebrovascular events [5] and a higher prevalence of postpartum HTN. These cardiovascular events are thought to be due to a direct impact on the cardiovascular system causing endothelial dysfunction in addition to their association with cardiovascular risk factors of obesity, physical inactivity, HTN, tobacco use, diabetes, and dyslipidemia. Approximately 16% of the USA's maternal mortality has been attributed to HDP [6], and these women are at a 1.5-fold increased risk of death.

Postpartum HTN is vastly underrecognized. A recent study of 988 women admitted for cesarean section found 18.6% of women developed postpartum HTN; 41.8% of these cases were de novo HTN [7]. During the first year after delivery, women with HDP have a 12- to 25-fold greater risk of developing chronic HTN, which is the most common cause for hospital readmission. A large retrospective study found that 63% of patients readmitted with delayed postpartum preeclampsia had no antecedent diagnosis of a hypertensive disorder of pregnancy [8].

Criteria for the diagnosis of hypertension and hypertensive disorders of pregnancy

The American College of Cardiology/American Heart Association guidelines have reclassified blood pressure (BP) criteria for stages of HTN. Normal BP is defined as systolic BP <120 mmHg and diastolic BP <80 mmHg and elevated BP as systolic BP between 120 and 129 mmHg and diastolic BP <80 mmHg, followed by stage 1 and stage 2 HTN as shown in Table 1 [9]. HDP are classified as chronic HTN (diagnosed prior to pregnancy or before 20 weeks of gestation); gestational HTN (HTN with BP of ≥140/90 mmHg in the absence of proteinuria diagnosed at 20 weeks of gestation or later); preeclampsia/eclampsia (increase in BP to ≥140/90 with concomitant proteinuria or organ damage); and preeclampsia superimposed on chronic HTN [10] as shown in Table 2. It is important to note that obstetric societies have yet to adopt the 2017 AHA guidelines for HTN, and it is debated whether a change in the BP threshold to 130/80 mmHg for the diagnosis and treatment of chronic HTN would lead to a change in perinatal outcomes. There is a growing body of evidence that adoption of these lower limits for BP will identify women at higher risk of maternal and neonatal mortality and morbidity including development of preeclampsia, preterm birth, and small for gestational age infants [11–13].

Risk factors for the development of postpartum hypertension

Despite the risk of immediate and future cardiac events associated with HDP, there are limited data regarding the risk factors that predispose certain women to this complication. There appears to be a dose-dependent effect of HDP and the risk of developing chronic HTN later in life in that the more severe the HTN was during pregnancy, the greater the risk. Chronic HTN is more likely to occur when GH occurs earlier in pregnancy and when the pregnancy is associated with iatrogenic preterm delivery and fetal growth disorders. In a study by Hauspurg et al. evaluating BP in nulliparous women, BP category and trajectory early in the pregnancy were independently associated with the risk of preeclampsia and GH [14]. The recurrence of preeclampsia in subsequent pregnancies has been shown to increase the risk of the development of chronic HTN when compared to women without recurrence [15]. Tooher et al. performed a retrospective analysis of 31,656 women, finding that 13.8% had HDP and 34% of this

Table 1. ACC/AHA stages and definition of hypertension

Stage of hypertension	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Normal blood pressure	<120	<80
Elevated blood pressure	120–129	<80
Stage 1 hypertension	130–139	80–89
Stage 2 hypertension	≥140	≥90

Table 2. ACOG definitions of hypertensive disorders of pregnancy

Diagnosis	Clinical criteria	Timing in pregnancy
Chronic hypertension (of any cause)	Systolic blood pressure ≥ 140 or diastolic blood pressure ≥ 90	Before pregnancy or before 20 weeks of gestation
Gestational hypertension	Systolic blood pressure ≥ 140 or diastolic blood pressure ≥ 90	Occurring after 20 weeks of gestation
Preeclampsia without severe features	Systolic blood pressure ≥ 140 or diastolic blood pressure ≥ 90 accompanied by proteinuria	Occurring after 20 weeks of gestation
Preeclampsia with severe features	Systolic blood pressure ≥ 140 or diastolic blood pressure ≥ 90 with evidence of end organ damage including thrombocytopenia, liver dysfunction, renal dysfunction, pulmonary edema, headache/vision changes, or severe elevation in blood pressures ≥160/≥110	Occurring after 20 weeks of gestation
Chronic hypertension with superimposed preeclampsia	Preexisting diagnosis of chronic hypertension as defined above with evidence of worsening disease by end organ damage	Occurring after 20 weeks of gestation

cohort had severe HTN defined as BP ≥170/110 mmHg [5]. The women with severe HTN tended to be older, delivered earlier, and had lower neonatal weights when compared to women who were normotensive during pregnancy. Goel et al. have shown that women with a higher body mass index and pregestational diabetes mellitus were more likely to develop postpartum HTN [7]. Finally, there are racial disparities with regard to the development of postpartum HTN. In a prospective study by Hauspurg et al. of 1077 women with HDP, BP rapidly decreased after 3 weeks and then stabilized in the majority of the population. However, black women had less of a rapid decline in BP compared to white women. At the end of the program, 68.1% of black women, compared to 51.4% of white women, met criteria for stage 1 or 2 HTN [16].

Etiologies and evaluation of postpartum hypertension

Postpartum HTN can be due to persistent GH, preeclampsia, or preexisting HTN. However, it may also be due to new-onset essential or de novo postpartum HTN or due to a secondary cause of HTN. HELLP syndrome (hemolysis, elevated liver function tests, and low platelet count) occurs in 30% of women during the postpartum period and is often considered to be on the spectrum of preeclampsia-related disorders. Other causes include pain medications such as nonsteroidal anti-inflammatory medications which can cause vasoconstriction and subsequent retention of sodium and water and HTN. Ergot alkaloids, like methylergonovine, are used at times for uterine atony and can also cause vasoconstriction and HTN. BP can also be elevated in patients with peripartum cardiomyopathy manifested by signs and symptoms of fluid retention as noted in Table 3. HTN associated with thunderclap headaches, focal neurological deficits, visual changes, and seizures should be suspected as having neurological

Table 3. Etiology of postpartum hypertension

Etiology	Suggestive signs and/or symptoms
Medications	Use of nonsteroidal anti-inflammatory agents, ergot alkaloids, oral contraceptives, antidepressants, corticosteroids, or chemotherapeutic agents (e.g., gemcitabine)
Hyperthyroidism (Graves' disease)	Systolic hypertension, wide pulse pressure, tachycardia, palpitations, tremors, heat intolerance, diarrhea, exophthalmos, lid lag, low serum thyroid stimulating hormone, high serum free T4
Hypothyroidism	Fatigue, weight gain, personal or family history of autoimmune disorders, enlarged thyroid gland, high serum thyroid-stimulating hormone
Primary aldosteronism	Unexplained hypokalemia, plasma aldosterone concentration/plasma renin activity >20–30, adrenal mass on CT/MRI
Pheochromocytoma	Paroxysmal headaches, palpitations, diaphoresis, hypertension, chest pain, postural hypotension, high 24-h urine fractionated metanephrines, adrenal mass on MRI or CT scan
Cushing's syndrome	Moon facies, central obesity, buffalo hump, proximal muscle weakness, glucocorticoid use, high late-night salivary or serum cortisol, high urinary cortisol concentration
Renal artery stenosis	Increase in serum creatinine >50% within 1 week of angiotensin-converting enzyme inhibitor or angiotensin receptor blocker initiation, severe hypertension with recurrent flash pulmonary edema, abdominal bruit lateralized to one side, elevated systolic flow velocity on duplex Doppler ultrasound
Primary kidney disease	Edema, elevated serum creatinine, proteinuria, hematuria
Primary/essential hypertension	Often without signs and symptoms, less often have nonspecific signs and symptoms: headache, epistaxis, dizziness, shortness of breath
Peripartum cardiomyopathy	Dyspnea on exertion, orthopnea, paroxysmal nocturnal dyspnea, elevated jugular venous pressure, pulmonary rales, lower extremity edema, elevated brain natriuretic peptide (BNP) or N-terminal-pro-hormone BNP, pulmonary vascular congestion and/or pleural effusion on chest radiograph
Coarctation of the aorta	Blood pressure in arms greater than legs, or right arm blood pressure greater than left arm; brachial-femoral delay, mid-systolic murmur best heard over posterior chest, rib notching on chest radiograph
Reversible vasoconstriction syndrome	Use of vasoconstrictive agents (triptans, ergotamine), selective serotonin reuptake inhibitors, serotonin-norepinephrine reuptake inhibitors, illicit drugs (cocaine, ecstasy). Thunderclap headache, focal neurological deficits (hemiplegia, tremor, hyperreflexia, ataxia, aphasia)
Elevated intracranial pressure	Visual changes and/or deficits, focal motor or sensory neurological deficits
Obstructive sleep apnea	Elevated BMI, morning headaches, daytime somnolence
HELLP syndrome	Presenting within 1 week of delivery, right upper quadrant pain, nausea and/or vomiting, headache, vision changes, proteinuria, anemia, abnormal liver function tests, thrombocytopenia

causes or sequelae of HTN such as cerebrovascular accident or reversible vasoconstriction syndrome. Reversible vasoconstriction syndrome compromises a group of conditions that cause multifocal narrowing of the cerebral arteries and neurological symptoms. It is more common in women, is associated with pregnancy, and is thought to be related to changes in estrogen and progesterone levels. These patients should be immediately evaluated by neurology and undergo computed tomography and magnetic resonance imaging of the brain

and possible cerebral venography. Less than 20% of patients will have residual neurological symptoms, and these deficits are usually considered minor in severity. Finally, endocrine disorders as well as primary renal disorders are other etiologies of postpartum HTN; a comprehensive list as well as their common signs and symptoms are listed in Table 3.

The evaluation and management of postpartum HTN will depend on the history including cardiac risk factors, active medications including the use of antihypertensive therapy during pregnancy, BP measurements during pregnancy, physical exam with particular attention to signs and symptoms of fluid overload, and the results of initial laboratory and imaging tests [17]. BP in patients with preeclampsia will usually decrease within 48 h after delivery but will often increase again after 3–6 days due to postpartum volume shifts.

Complications of postpartum hypertension

In the immediate postpartum period, women with HDP are at a higher risk of hypertensive urgency/emergency and stroke. The most common cause of death in women with preeclampsia is intracerebral hemorrhage. Women who develop postpartum hypertension after completing a pregnancy with normal blood pressures are at a higher risk of seizures due to postpartum eclampsia which is associated with significant morbidity and mortality.

Women with preeclampsia are at a high risk of progression to chronic HTN or persistent HTN during the first year following HDP. A study evaluating ambulatory BP monitoring (measuring BP over a continuous 24-h period) and office BP readings of women with preeclampsia with severe features demonstrated that 42% had persistent HTN at 1 year with approximately 18% discovered by ambulatory monitoring [18]. This study highlights how informative frequent office visits and ambulatory BP measurement can be in the surveillance and management of postpartum hypertension in patients with elevated risk.

Treatment

The data regarding effective pharmacological treatment of postpartum HTN are limited. Beta-blockers and calcium channel blockers are most commonly used and have been shown to enter breast milk but at a level that appears to be safe for the infant [19]. In a meta-analysis of 39 studies by Cairns et al., the authors were not able to recommend one specific antihypertensive medication or BP threshold for the management of postpartum HTN because the results of each study were so variable [20]. This highlights the significant gap in knowledge on how to treat this patient population, which medications are more effective, and the thresholds for initiation, escalation, and discontinuation. Medications that are considered safe to use in the postpartum period while breast feeding are listed in Table 4 with their mechanisms of action and common side effects. Some commonly used postpartum antihypertensive medications include labetalol, diltiazem, nifedipine, hydrochlorothiazide, and captopril. In a randomized control of 90 postpartum women with HDP (defined as a systolic blood pressure $\geq$ 180 mmHg and/or diastolic blood pressure $\geq$ 110 mmHg requiring magnesium sulfate) who were randomized equally to treatment with

Table 4. Medications for management of hypertension during lactation

Category	Medications [21]	Mechanism [22]	Adverse effects [22]
Beta blocker	Propranolol, labetalol, metoprolol	Competitively inhibits beta-1 and/or beta-2 receptors, reducing sympathetic responses	Fatigue, bronchospasm, AV block
Angiotensin-converting enzyme (ACE) inhibitor	Captopril, enalapril	Blocks formation of angiotensin II, promoting diuresis and decreasing vasoconstriction	Cough, hypotension, hyperkalemia, renal insufficiency, angioedema, fetal hypotension, fetal oliguria and seizures
Alpha-2 adrenergic agonist	Methyldopa	Inhibits alpha-adrenergic sympathetic activation	Orthostatic hypotension, mental depression, positive Coombs test
Thiazide diuretic	Hydrochlorothiazide	Decreases absorption in the distal tubule and collecting segment	Hypokalemia, hyperuricemia, hyponatremia, hyperglycemia, hyperlipidemia, hypomagnesemia
Dihydropyridine calcium channel blocker	Nicardipine, amlodipine	Blocks L-type calcium channels primarily in smooth muscle, leading to vasodilation	Peripheral edema, flushing, reflex tachycardia, headache
Non-dihydropyridine calcium channel blocker	Verapamil	Blocks L-type calcium channels in smooth and cardiac muscle, leading to vasodilation and reduced cardiac output	Atrioventricular block, bradycardia, peripheral edema, rash
Arteriolar vasodilator	Hydralazine	Reduces vascular resistance at level of the arterioles	Headache, flushing, tachycardia, edema, lupus-like syndrome

clonidine vs. captopril, the primary outcome was elevated BP episodes in the intensive care unit. There was a trend toward fewer hypertensive episodes, greater systolic BP reduction, and fewer women requiring intravenous sodium nitroprusside in the group receiving clonidine; however, this was not statistically significant. Adverse reactions were more common but not significantly different in the captopril group (28.8%) vs. the clonidine group (18.6%) with the most common being dry cough, nausea, rash, and fever [23]. Patients with preeclampsia with severe features, eclampsia, or HELLP syndrome are usually treated with intravenous magnesium sulfate and antihypertensive medications with most improving within 48 h of onset [17].

The use of furosemide in conjunction with other oral antihypertensive medications has also shown promise in controlling postpartum BP and reducing the number of agents needed for BP control. Ascarelli et al. performed a randomized controlled trial comparing furosemide to no therapy and noted that patients with preeclampsia with severe features who received furosemide had lower systolic BP by postpartum day 2 and required less antihypertensive therapy during hospitalization [24]. Perdigao et al. also performed a randomized, double-blind, placebo-controlled trial of a 5-day course of oral furosemide in women with both gestational HTN and preeclampsia with and without

severe features, and they noted a 60% reduction in the prevalence of persistently elevated BP at 7 days [25].

Diet and exercise

There is little data examining the role of diet and exercise intervention during and after pregnancy. A Cochrane systemic review of randomized control trials evaluated 49 trials with such interventions and included 11,444 women [26]. Overall, weight management interventions led to a reduction in the number of women gaining excess weight by approximately 20% over the duration of their pregnancy. The authors found no clear benefit of diet or exercise interventions, or both, on the incidence of preeclampsia, cesarean section, and preterm birth. However, maternal HTN was reduced with these interventions. The benefits of the DASH diet (Dietary Approaches to Stop Hypertension) trial of consuming more fruits, vegetables, and low-fat dairy products in patients with systolic BP <160 mmHg and diastolic BP of 80-95 mmHg were shown to have a reduction in systolic and diastolic BP by 5.5 and 3 mmHg, respectively [27]. In a recent meta-analysis of 41 trials, the DASH diet and a lacto-ovo vegetarian diet reduced systolic BP by 5.5 mmHg on average, which was a larger reduction than the effects of a Mediterranean diet, high-fiber diet, and vegan diet [28]. These studies did not include pregnant women, however, highlighting the need for investigations evaluating the impact of diet and exercise on BP during and after pregnancy.

Monitoring

The National Institute for Health and Care Excellence recommends frequent BP monitoring during the postnatal period in patients with preeclampsia and GH. They recommend BP checks every 1–2 days for 2 weeks in the former and once in days 3–4 for the latter. The American College of Obstetricians and Gynecologists (ACOG) Guidelines suggest BP monitoring in the first 72 h postpartum and 7 to 10 days after delivery for women with HDP, although the supporting evidence is limited [29]. Asymptomatic women can be discharged with ambulatory monitoring and discontinuation of antihypertensive medications if BP readings remain normal according to ACOG criteria. Women with mild HTN may be discharged prior to 72 h with close follow-up.

Recently, it has been recommended to screen women who experience complications during pregnancy for cardiovascular risk factors during the postpartum period, and it is urged to establish best practices at a local level to implement such screening [30]. Traditionally, the postpartum visit occurs 6 weeks after delivery; however, it has been shown that close to half of women do not attend this visit. Women with HDP have been shown to attend these visits more often than normotensive women; however, the overall attendance rates remain low. In a retrospective cohort study by Lewey at al., using insurance claims from a US health insurance database of 566,059 women who completed pregnancies between 2005 and 2014, 11% had HDP and 4% had chronic HTN. Only 58% of women with HDP had a 6-month follow-up with any continuity provider and 26% at 1 year. Risk factors associated with a lower rate of follow-up included age ≥ 30, Black race, Hispanic ethnicity, and a history of

multiparity. These low rates of follow-up are missed opportunities for cardiovascular screening and cardiac risk management in these women.

In an attempt to address this, the ACOG created a postpartum evaluation algorithm which assigns responsibility to the maternal primary care provider for comprehensive postpartum care. They recommend a BP check 3–10 days after delivery and that high-risk patients be scheduled for follow-up within 1–3 weeks [29]. ACOG recommends contact with all women within the first 3 weeks, ongoing follow-up from 3 to 12 weeks postpartum, and a comprehensive postpartum visit with transition to well-woman care at 4–12 weeks. Figure 1 provides a timeline for recommended postpartum BP checks and clinic visits for women with HDP.

To further emphasize the importance of postpartum care, the ACOG has coined the term the "4th trimester" to address the physical, mental, and emotional challenges that women face during the 3 months after delivery. Providers should aim to have a postpartum visit occurring 3 weeks postpartum which would provide an early opportunity to screen for cardiovascular risk factors such as hypertension, dyslipidemia, physical inactivity, obesity, impaired glucose tolerance, and diabetes. The medical providers involved in this postpartum visit can include those from internal medicine, family medicine, and obstetrics and gynecology. Also, since the requirements for antihypertensive therapy change during the postpartum period with many patients requiring higher doses immediately postpartum and a majority of patients being treatment-free by 3–6 months [20], frequent monitoring will allow these changes to be made in a timely, supervised fashion.

Prevention

Approximately 77% of the excess long-term cardiovascular risk associated with HDP is due to modifiable risk factors [31]. Medical providers caring for postpartum women should be educated about the importance of monitoring BP early after delivery and should also include assessment of other cardiac risk factors. Groenhof et al. estimated that 9 women around the age of 35 years would need to be screened to detect 1 clinically relevant case of HTN, highlighting the small number of women that need to be screened to make a significant impact.

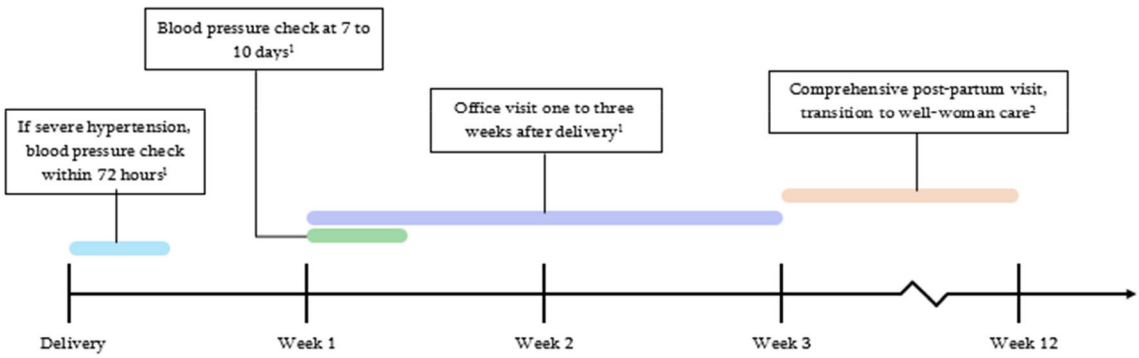

Fig. 1. Timeline of follow-up after delivery for patients who had a hypertensive disorder in pregnancy

In order to consistently screen women for postpartum HTN, there is a need for a structured, comprehensive, and systematic approach. Creating comprehensive guidelines and implementing best practices at a local level regarding the frequency and monitoring are also a crucial part for helping healthcare professionals care for these women. Evidence based recommendations regarding the categories of antihypertensive medications that are most effective as well as guidance for the escalation and de-escalation of these medications would be important to improve postpartum care.

The importance of providing education to pregnant women with HDP is critical. Discharge instructions should emphasize the importance of BP monitoring, how to check their BPs, and education about the signs and symptoms of severe HTN. Ideally, these patients should be provided a blood pressure monitoring device prior to discharge. Most women with HDP are not aware of the association of HDP with future cardiovascular events, and it is important that they understand that risk. This will empower them to engage in their care and modify their risk factors with self-tracking and monitoring. Ambulatory blood pressure monitoring is easy to use and inexpensive and allows for monitoring of blood pressure over an extended period of time [32].

While some of this crucial patient education can be done during a 6-week postpartum visit, the overall poor attendance of patients at this visit significantly hinders a provider's ability to do so. There are numerous barriers to attending these postpartum visits that need to be recognized and addressed. Women face postpartum fatigue, pain, postpartum depression and exacerbation of mental illness, infant caretaking and feeding, as well as childcare for other dependents during the timeframe of these visits. Finally, many women lose their healthcare coverage 6 weeks after delivery. Digital health and tele-visits would improve access for these women and address some of the barriers mentioned above.

Finally, there is an economic incentive to screen these women as there is a significant healthcare cost for the treatment of patients with preeclampsia. One study estimated a cost of $2.18 billion for these patients and their infants for 12 months post-delivery in 2012 [6].

Mobile health interventions in postpartum hypertension management

Early postpartum healthcare follow-up has been associated with better maternal and fetal outcomes [33]. Yet unfortunately, it has been estimated that only 40% of women attend face-to-face follow-up with a healthcare provider 6 weeks after delivery [29]. This emphasizes the need for innovative models to improve rates of follow-up and better accessibility of healthcare monitoring and intervention for postpartum women.

Digital health resources and interventions are becoming readily available and more popular among mothers when compared to in-person follow-up. This is likely due to lower burden of transportation, less cost, and availability of online support. In the Framingham Health eHeart study, women were shown to have higher enrollment rates than men in digital blood pressure and activity tracking with a Fitbit over the course of a 5-month intervention [34].

In a case control study by Van den Heuvel et al., a care plan was designed with reduced visits enhanced with a digital platform for daily blood pressure and symptom monitoring starting from 16 weeks of gestation and compared to a retrospective control group managed without self-monitoring. Women enrolled in the digital platform had lower antenatal visits, yet fewer admissions for hypertension or suspected preeclampsia [35]. A prospective single-cohort feasibility study was done at the University of Wisconsin to investigate the feasibility of telehealth with remote blood pressure monitoring for management of hypertension in postpartum women at risk of severe hypertension after hospital discharge. Participants received a tablet and equipment to transmit vital signs to a central monitoring site daily and participated in telehealth or telephone visits with a nurse at 48 h and as needed. Among study participants, the incidence of severe HTN after discharge was 16%; 53% of participants required treatment due to exacerbations in BP after discharge. There were no hospital readmissions, and, overall, 86% of participants were satisfied with the remote monitoring. Text message–based programs have been shown to improve patient engagement and BP monitoring [36]. Telehealth is a promising platform for postpartum HTN management to improve maternal morbidity and decrease hospital readmissions.

Conclusion

In general, there are three times during a woman's life that she routinely receives medical care: infancy, pregnancy/postpartum, and when she develops a chronic medical condition. The postpartum period provides an opportunity for medical providers to screen for cardiovascular risk factors and conditions. HDP are a common complication of pregnancy and often underdiagnosed and treated in the postpartum period despite a well-established association with significant maternal cardiovascular morbidity and mortality. Prevention and detection are key. Optimization of women's health status not only improves their outcomes during future pregnancies but also decreases cardiovascular events and mortality in the long term.

Compliance With Ethical Standards

Conflict of interest

Colleen M. Harrington declares that she has no conflict of interest.
Nouran Sorour declares that she has no conflict of interest.
Stephen Troy declares that he has no conflict of interest.
Mina Botros declares that he has no conflict of interest.
Marissa Ciuffo declares that she has no conflict of interest.
Nicole Sardella declares that she has no conflict of interest.
Gianna Wilkie declares that she has no conflict of interest.
Gerard P. Aurigemma declares that he has no conflict of interest.
Lara C. Kovell declares that she has no conflict of interest.

Human and animal rights and informed consent
This article does not contain any studies with human or animal subjects performed by any of the authors.

References and Recommended Reading

Papers of particular interest, published recently, have been highlighted as:
• Of importance
•• Of major importance

1. Cirillo PM, Cohn BA. Pregnancy complications and cardiovascular disease death: 50-year follow-up of the child health and development studies pregnancy cohort. Circulation. 2015;132(13):1234–42. https://doi.org/10.1161/CIRCULATIONAHA.113.003901.
2. Martin JA, Hamilton BE, Osterman MJK, Driscoll AK, Drake P. Births: final data for 2017. Natl Vital Stat Rep. 2018;67(8):1–50.
3. Wallis AB, Saftlas AF, Hsia J, Atrash HK. Secular trends in the rates of preeclampsia, eclampsia, and gestational hypertension, United States, 1987-2004. Am J Hypertens. 2008;21(5):521–6. https://doi.org/10.1038/ajh.2008.20.
4. Bellamy L, Casas JP, Hingorani AD, Williams DJ. Pre-eclampsia and risk of cardiovascular disease and cancer in later life: systematic review and meta-analysis. BMJ. 2007;335(7627):974. https://doi.org/10.1136/bmj.39335.385301.BE.
5.•• Tooher J, Thornton C, Makris A, Ogle R, Korda A, Hennessy A. All hypertensive disorders of pregnancy increase the risk of future cardiovascular disease. Hypertension. 2017;70(4):798–803. https://doi.org/10.1161/HYPERTENSIONAHA.117.09246

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6. Gestational hypertension and preeclampsia: ACOG practice bulletin summary, number 222. Obstet Gynecol. 2020;135(6):1492–5. https://doi.org/10.1097/AOG.0000000000003892.
7. Goel A, Maski MR, Bajracharya S, Wenger JB, Zhang D, Salahuddin S, et al. Epidemiology and mechanisms of de novo and persistent hypertension in the postpartum period. Circulation. 2015;132(18):1726–33. https://doi.org/10.1161/CIRCULATIONAHA.115.015721.
8. Al-Safi Z, Imudia AN, Filetti LC, Hobson DT, Bahado-Singh RO, Awonuga AO. Delayed postpartum pre-eclampsia and eclampsia: demographics, clinical course, and complications. Obstet Gynecol. 2011;118(5):1102–7. https://doi.org/10.1097/AOG.0b013e318231934c.
9. Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Dennison Himmelfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: executive summary: a report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. Hypertension. 2018;71(6):1269–324. https://doi.org/10.1161/HYP.0000000000000066.
10. Sutton ALM, Harper LM, Tita ATN. Hypertensive disorders in pregnancy. Obstet Gynecol Clin N Am. 2018;45(2):333–47. https://doi.org/10.1016/j.ogc.2018.01.012.
11. Sutton EF, Hauspurg A, Caritis SN, Powers RW, Catov JM. Maternal outcomes associated with lower range stage 1 hypertension. Obstet Gynecol. 2018;132(4):843–9. https://doi.org/10.1097/AOG.0000000000002870.
12. Smith GN, Pudwell J, Saade GR. Impact of the new American hypertension guidelines on the prevalence of postpartum hypertension. Am J Perinatol. 2019;36(4):440–2. https://doi.org/10.1055/s-0038-1669441.
13. Sisti G, Williams B. Body of evidence in favor of adopting 130/80 mm Hg as new blood pressure cut-off for all the hypertensive disorders of pregnancy. Medicina (Kaunas). 2019;55(10). https://doi.org/10.3390/medicina55100703.
14. Hauspurg A, Parry S, Mercer BM, Grobman W, Hatfield T, Silver RM, et al. Blood pressure trajectory and category and risk of hypertensive disorders of pregnancy in nulliparous women. Am J Obstet Gynecol. 2019;221(3):277 e1- e8. https://doi.org/10.1016/j.ajog.2019.06.031.
15. Melchiorre K, Thilaganathan B, Giorgione V, Ridder A, Memmo A, Khalil A. Hypertensive disorders of pregnancy and future cardiovascular health. Front Cardiovasc Med. 2020;7:59. https://doi.org/10.3389/fcvm.2020.00059.
16. Hauspurg A, Lemon L, Cabrera C, Javaid A, Binstock A, Quinn B, et al. Racial differences in postpartum blood pressure trajectories among women after a hypertensive disorder of pregnancy. JAMA Netw Open. 2020;3(12):e2030815. https://doi.org/10.1001/jamanetworkopen.2020.30815.
17. Sibai BM. Etiology and management of postpartum hypertension-preeclampsia. Am J Obstet Gynecol. 2012;206(6):470–5. https://doi.org/10.1016/j.ajog.2011.09.002.

18. Benschop L, Duvekot JJ, Versmissen J, van Broekhoven V, Steegers EAP. Roeters van Lennep JE. Blood pressure profile 1 year after severe preeclampsia. Hypertension. 2018;71(3):491–8. https://doi.org/10.1161/HYPERTENSIONAHA.117.10338.
19. Beardmore KS, Morris JM, Gallery ED. Excretion of antihypertensive medication into human breast milk: a systematic review. Hypertens Pregnancy. 2002;21(1):85–95. https://doi.org/10.1081/PRG-120002912.
20. Cairns AE, Pealing L, Duffy JMN, Roberts N, Tucker KL, Leeson P, et al. Postpartum management of hypertensive disorders of pregnancy: a systematic review. BMJ Open. 2017;7(11):e018696. https://doi.org/10.1136/bmjopen-2017-018696.
21. Drugs and lactation database (LactMed) [Internet] [database on the Internet]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK501922/. Accessed:
22. Katzung BG, Trevor AJ. Basic & clinical pharmacology. 13th ed: McGraw Hill Education; 2015.
23. Noronha Neto CC, Maia SS, Katz L, Coutinho IC, Souza AR, Amorim MM. Clonidine versus captopril for severe postpartum hypertension: a randomized controlled trial. PLoS One. 2017;12(1):e0168124. https://doi.org/10.1371/journal.pone.0168124.
24. Ascarelli MH, Johnson V, McCreary H, Cushman J, May WL, Martin JN Jr. Postpartum preeclampsia management with furosemide: a randomized clinical trial. Obstet Gynecol. 2005;105(1):29–33. https://doi.org/10.1097/01.AOG.0000148270.53433.66.
25. Lopes Perdigao J, Lewey J, Hirshberg A, Koelper N, Srinivas SK, Elovitz MA, et al. Furosemide for accelerated recovery of blood pressure postpartum in women with a hypertensive disorder of pregnancy: a randomized controlled trial. Hypertension. 2021:HYPERTENSIONAHA12016133. https://doi.org/10.1161/HYPERTENSIONAHA.120.16133.
26. Muktabhant B, Lawrie TA, Lumbiganon P, Laopaiboon M. Diet or exercise, or both, for preventing excessive weight gain in pregnancy. Cochrane Database Syst Rev. 2015;6:CD007145. https://doi.org/10.1002/14651858.CD007145.pub3.
27. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. N Engl J Med. 1997;336(16):1117–24. https://doi.org/10.1056/NEJM199704173361601.
28. Gibbs J, Gaskin E, Ji C, Miller MA, Cappuccio FP. The effect of plant-based dietary patterns on blood pressure: a systematic review and meta-analysis of controlled intervention trials. J Hypertens. 2021;39(1):23–37. https://doi.org/10.1097/HJH.0000000000002604.
29.•• McKinney J, Keyser L, Clinton S, Pagliano C. ACOG Committee opinion no. 736: optimizing postpartum care. Obstet Gynecol. 2018;132(3):784–5. https://doi.org/10.1097/AOG.0000000000002849
The American College of Obstetricians and Gynecologists discuss postpartum evaluation algorithm which assigns responsibility to the maternal primary care provider for comprehensive postpartum care.
30. Patient S. Quality committee SfM-FMEasso, Gibson KS, Hameed AB. Society for maternal-fetal medicine special statement: checklist for postpartum discharge of women with hypertensive disorders. Am J Obstet Gynecol. 2020;223(4):B18–21. https://doi.org/10.1016/j.ajog.2020.07.009.
31. Haug EB, Horn J, Markovitz AR, Fraser A, Klykken B, Dalen H, et al. Association of conventional cardiovascular risk factors with cardiovascular disease after hypertensive disorders of pregnancy: analysis of the Nord-Trondelag health study. JAMA Cardiol. 2019;4(7):628–35. https://doi.org/10.1001/jamacardio.2019.1746.
32. Bello NA, Miller E, Cleary K, Wapner R, Shimbo D, Tita AT. Out of office blood pressure measurement in pregnancy and the postpartum period. Curr Hypertens Rep. 2018;20(12):101. https://doi.org/10.1007/s11906-018-0901-z.
33. Goulet L, D'Amour D, Pineault R. Type and timing of services following postnatal discharge: do they make a difference? Women Health. 2007;45(4):19–39. https://doi.org/10.1300/J013v45n04_02.
34. Spartano NL, Lin H, Sun F, Lunetta KL, Trinquart L, Valentino M, et al. Comparison of on-site versus remote Mobile device support in the Framingham heart study using the health eHeart study for digital follow-up: randomized pilot study set within an observational study design. JMIR Mhealth Uhealth. 2019;7(9):e13238. https://doi.org/10.2196/13238.
35.•• van den Heuvel JFM, Lely AT, Huisman JJ, JCA T, Franx A, Bekker MN. SAFE@HOME: digital health platform facilitating a new care path for women at increased risk of preeclampsia - a case-control study. Pregnancy Hypertens. 2020;22:30–6. https://doi.org/10.1016/j.preghy.2020.07.006
The importance of digital platforms in the care of women during pregnancy. The authors designed a digital platform for daily blood pressure and symptom monitoring starting from 16 weeks of gestation and compared to a retrospective control group managed without self-monitoring. Women enrolled in the digital platform had lower antenatal visits, yet fewer admissions for hypertension or suspected preeclampsia.
36. Hoppe KK, Williams M, Thomas N, Zella JB, Drewry A, Kim K, et al. Telehealth with remote blood pressure monitoring for postpartum hypertension: a prospective single-cohort feasibility study. Pregnancy Hypertens. 2019;15:171–6. https://doi.org/10.1016/j.preghy.2018.12.007.

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