Reflections in Hypertension

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How Should Blood Pressure Be Measured During Pregnancy?

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Hypertension is the second leading cause of maternal deaths in the United States (after embolism), and is also a major cause of stillbirths and neonatal mortality. Since it is no less treatable during pregnancy than at other times, it comes as no surprise that measurement of blood pressure (BP) during pregnancy is one of the most important aspects of prenatal care. In normal pregnancies, both systolic and diastolic pressure decrease about 5–10 mm Hg by the middle of pregnancy, and then gradually increase to the starting levels at term. Hypertension may, of course, precede pregnancy, but more commonly develops during it, in which case it may be classified as gestational hypertension or preeclampsia. In both cases, BP levels can change very quickly: the increase of BP rarely starts before ≈20 weeks, but may be a major problem by the third trimester (24–36 weeks). The official US guidelines on the management of high BP during pregnancy published by the working group of the National High Blood Pressure Education Program, which was most recently revised in July 2000,[1] are surprisingly silent on how BP should be measured. There is a brief statement saying that diastolic pressure should be measured using the fifth phase of the Korotkoff sounds, and there is also a recommendation that in women who are hypertensive before pregnancy "the diagnosis should be confirmed by multiple measurements and may incorporate home or other out-of-office BP readings." There is no statement concerning how frequently BP should be measured, nor on the use of out-of-office monitoring.

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SYSTOLIC OR DIASTOLIC PRESSURE?

The aspect of BP measurement during pregnancy that has received the most attention has been the debate as to whether diastolic pressure should be registered by the 4th or 5th phase Korotkoff sound. Pregnancy is the only situation where phase 4 ever had much support as the best measure of diastolic pressure because it was stated that in many pregnant women, Korotkoff sounds might be audible even when there was no pressure in the cuff which would, of course, give a 5th-phase diastolic reading of zero. While it certainly can occur, it is quite rare; in one study of 197 pregnant women, it did not occur even once.[2]

Preeclampsia may be one of the last bastions of the supremacy of diastolic pressure. In a recent review (2001), it was proposed that hypertension of pregnancy should be principally defined by diastolic pressure.[3] There are two classic studies showing the increased risk associated with hypertension during pregnancy, both made in the years before preeclampsia was systematically treated. One used the mean pressure to predict risk in 15,000 women,[4] and the other (the Collaborative Prenatal Project) used diastolic pressure[5] in 38,000 women, but stated that the relationships were very

similar for systolic pressure. More recent studies (described below) examining the relative roles of systolic and diastolic ambulatory pressure in predicting the onset of preeclampsia have not reached any consensus as to which is better. And, as discussed previously in this series,[6] isolated elevation of diastolic pressure is not necessarily associated with any increased risk, although diastolic pressure generally does have predictive value in younger people.[7] In view of the widely acknowledged problems in the measurement of diastolic pressure during pregnancy, it would seem logical to place greater emphasis on systolic pressure.

CLINIC BP MEASUREMENT DURING PREGNANCY

Physicians, in general, are not known for their skills in taking accurate BPs, and obstetricians are no exception. Most read BP only to the nearest 5 or 10 mm Hg, and many never use a large cuff.[8] In the Collaborative Prenatal Project described above, there was a huge degree of terminal digit preference, with more than 65% of all readings ending in zero (0), and only 4% in a two (2).[5] The real-life problems of BP measurement during pregnancy were nicely illustrated by a report from Johns Hopkins Hospital,[9] which for many years has been regarded as somewhere you go for excellent care. The study compared BPs recorded by a project coordinator equipped with a Hawksley random zero device against readings measured routinely by the clinic staff. The subjects were 149 young women enrolled in a clinical trial of calcium supplementation. The project coordinator obtained significantly lower systolic pressures throughout the study (from 20–40 weeks of pregnancy), with differences of ≈10 mm Hg during the second trimester, and 5 mm Hg during the third. For diastolic pressure, the project coordinator got readings that were higher than the staff readings, but here the difference was greater during the third trimester (again, about 10 mm Hg). What was particularly striking was a plot of the diastolic pressure, which showed an unwavering level of 60 mm Hg from weeks 20–36 recorded by the clinic staff, and a steady but modest increase for the coordinator's readings. A histogram confirmed that there was a huge degree of terminal digit preference (reading to the nearest 10 mm Hg) for the clinic staff.

The National High Blood Pressure Education Program guidelines give little credence to the issues of BP variability and the need for multiple measurements, and simply state that chronic hypertension of pregnancy is diagnosed if the pressure exceeds 140 (systolic) or 90 (diastolic) mm Hg. It is also stated that "gestational BP elevation should be defined on the basis of at least two determinations. The repeat BP should be performed in a manner that will reduce the likelihood of artifact and/or patient anxiety." By this criterion, any woman whose BP during any visit after the 20th week shows two readings above either 140 systolic or 90 diastolic pressure is labeled as hypertensive.

WHITE COAT HYPERTENSION DURING PREGNANCY: VERY COMMON OR VERY RARE?

White coat hypertension occurs in about 20% of the general hypertensive population; it has been described in children as well as in older hypertensives, and tends to occur somewhat more commonly in women than in men,[10] so it is only to be expected that it occurs in pregnant women. During pregnancy, however, estimates vary widely, from as high as 60% to as low as 3%. Three studies that have given these disparate estimates are reviewed below.

The first was conducted in Italy by Bellomo et al.,[11] who recruited 144 women found to be hypertensive in the third trimester of pregnancy, defined by measurements made on two separate clinic visits yielding a systolic pressure of ≥140, or a diastolic of ≥90. They also included 106 women with normal BPs at the same stage of their pregnancies. Women who were already known to be hypertensive before pregnancy, or who were taking antihypertensive drugs, were excluded. All of the women wore a 24-hour BP monitor while hospitalized. The upper limit of normal for the 24-hour pressures was taken as 125/74 mm Hg based on the 90th percentile of BP recorded in normal pregnancies. Using this as a cut-off point, 42 (29.2%) of the women who were hypertensive by the conventional measurements were found to be normotensive by the 24-hour criteria, and hence by definition had white coat hypertension. The 24-hour values were not disclosed to the womens' physicians, however. The incidence of preeclampsia (defined by the combination of office hypertension and proteinuria more than 300 mg/24 h) was 61.7% in the group with sustained hypertension, but only 7.1% in the white coat hypertensives, which was not significantly different from the rate in the true normotensives (5.8%). Cesarean section was chosen for delivery in 41.1% of the true hypertensives, 45.2% of the white coat hypertensives, but only 12.4% of the normotensives. Neonatal weights were smaller in the true hypertensives (2911 g) than in either

the white coat hypertensives (3435 g) or the normotensives (3336 g). In accordance with this, the average duration of hospital stay was longer in the true hypertensives (12.3 days) than in the white coat hypertensives (6.9 days) or the normotensives (5.3 days). These results suggest that white coat hypertension of pregnancy is not only common but also benign, since few of the women classified as having it went on to develop preeclampsia, and few showed impaired fetal development. The fact that so many of the white coat hypertensives underwent cesarean section presumably reflects that fact that their obstetricians were going by the conventionally recorded pressures, and that in all probability the cesareans were mostly unnecessary.

These results were confirmed by an Israeli study of 60 women who developed hypertension during the second trimester who also wore 24-hour monitors.[12] Thirty-seven (62%) of these women were diagnosed with white coat hypertension, and they had less preeclampsia (8% vs. 56%), less intrauterine growth restriction (13% vs. 43%), and less preterm delivery (30% vs. 65%) than the women with sustained hypertension.

The third study[13] reported white coat hypertension in only 3% of pregnant women who were hypertensive during the second trimester. However, this low prevalence is almost certainly due to the way in which the "clinic" BP was measured, which was quite different from a normal clinic measurement. The study patients were about 50:50 outpatients and inpatients; for the former, clinic BP was measured by a midwife four to six times over a 4-hour period, which would be expected to give a much lower reading than obtained during a typical clinic visit. For the inpatients, six readings were taken between 6 a.m. and 9 p.m. on the same day that the ambulatory recording was made. It comes as no surprise that there was close agreement between the two sets of readings, and hence a low prevalence of white coat hypertension in this study.

Putting these three reports together, it seems reasonable to conclude that when clinic BP is measured in the conventional way, white coat hypertension is a significant problem.

AMBULATORY MONITORING DURING PREGNANCY: A PROMISE UNFULFILLED?

A more reliable way of detecting the onset of preeclampsia would be of great value, and since ambulatory BP (ABP) generally predicts risk better than clinic pressure, attempts have been made to identify early predictors using ABP monitoring. Two approaches have been used; the first is to look for changes in the diurnal rhythm of BP, and the second to look for changes in level.

A number of studies have examined the diurnal rhythm of BP in pregnant women and, in particular, those with hypertension. It has been suggested that preeclampsia may be characterized by a reduction of the normal nocturnal dipping pattern that could be detected relatively early in pregnancy.[14,15] However, others have not found this.[16,17] The most extensive publications on 24-hour BP measurements in pregnancy have come from Dr. Ramon Hermida, who works at the Chronobiology Laboratory in Vigo, Spain, and who for many years has routinely been performing ambulatory monitoring every 4 weeks on women throughout their pregnancies.[18–21] Two aspects distinguish this approach: first, the recordings are performed for 48 hours rather than 24 hours and second, he uses a "chronobiological" approach for quantifying the diurnal BP profile. The rationale for using 48 hours is that it is much better than a 24-hour recording for seeing the whole diurnal profile. A curve is fitted to the recorded profile, which is based on a cosine curve with harmonics added to allow for the fact that the diurnal profile is not symmetrical. The average level of BP over the whole 24 hours can be expressed as the midline estimating static of rhythm (MESOR), which is basically the average level of the fitted curve, or the hyperbaric index, that is the area of the curve above a threshold level. It is claimed that these measures may be more reliable than taking the simple time-weighted average. The amplitude of the circadian rhythm can also be expressed by this analysis, which actually shows an increase in preeclampsia, not a decrease.[20] While these analyses are of scientific interest, they have so far had no implications for clinical practice, partly because 48-hour recordings performed every 4 weeks is not a practical proposition, and also because the sensitivity of the test for predicting preeclampsia in early pregnancy is still relatively low. In addition, the software that comes with the available 24-hour monitors does not include chronobiological analysis.

The second approach has been to examine early changes in the average level of ABP. A study of more than 1100 primigravid women during the second trimester found that although higher 24-hour levels were recorded in the women who went on to develop preeclampsia than in the rest, the differences were too small to be of much value. The sensitivity of an elevated 24-hour mean diastolic pressure was only 22%, and the positive predictive

value 15%.[17] Systolic pressure was even less predictive. At the other extreme, the study by Bellomo et al.[11] concluded that an elevated ABP during the. third trimester had a sensitivity of 87% and a positive predictive value of 78%. The main findings of the Hermida group[18–21] are that both the MESOR and the hyperbaric index show minor elevations as early as the first trimester in women who are developing preeclampsia.[21] Other studies looking at this question have been reviewed by Feldman.[22]

HOME MONITORING DURING PREGNANCY: A PROMISE UNTESTED?

Given the pronounced changes of BP throughout pregnancy, and the acknowledged inaccuracies of conventional measurement, it is not hard to make a case for using self monitoring. Several monitors have been validated for use in pregnant women.[23] Although some studies have been done to show that self monitoring is practical[24] and has the potential to reduce clinic visits,[25] it has yet to be shown to what extent it will improve the evaluation and management of hypertension during pregnancy.

CONCLUSIONS

It would be hard to think of a clinical situation where the accurate tracking of BP is of more critical importance than pregnancy. The situation in pregnancy is essentially dynamic: BP first falls and then rises, so the best way of detecting an abnormal pattern that presages preeclampsia may be to monitor its changes very frequently throughout the course of pregnancy. Thus the earliest manifestation of preeclampsia is a failure to decrease, or a premature increase, of BP during the second trimester. ABP monitoring, which is becoming regarded as the gold standard for BP measurement, is good at getting detailed information about BP at one point in time, but it is not suited to monitoring subtle changes over time. A single ABP recording performed at this time would be unlikely to detect this altered trajectory, since there would be no comparison ABP recording from which a change could be detected. Self monitoring with home BP recordings is better suited to this task, since it is the best technique for providing multiple readings recorded at the same time of day over prolonged periods of time. Self monitoring is also a good technique for avoiding the vagaries of the human observer. What we need, therefore, are studies using self monitoring to chart the time course of BP changes in normal pregnancies and comparing them with the course in women who go on to develop preeclampsia.

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