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Relation between prenatal maternal blood pressure and infant irritability*

ANNELIESE F. KORNER, TINA GABBY and HELENA C. KRAEMER

Department of Psychiatry and the Behavioral Sciences, Stanford University School of Medicine, Stanford, Calif. 94305, U.S.A.

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SUMMARY

Chisholm et al. [4], using samples of Navajo and Malaysian newborns, found a significant positive relation between maternal normotensive blood pressures during the second trimester of pregnancy and at delivery and infant irritability in response to the Brazelton Examination. Measuring spontaneous crying with an electronic activity monitor and using a white middle-class American population, this relation was replicated for mothers with normotensive blood pressures during the third trimester of pregnancy. The combined findings of the 3 studies seem to suggest that maternal blood pressure in the latter part of pregnancy, even when within normal limits, is a factor in how irritable normal newborn infants are.

prenatal influences; maternal blood pressure; infant irritability

In a recent paper, Chisholm, Woodson and Da Costa Woodson [4] reported a significant positive relation between prenatal normotensive maternal blood pressures and newborn irritability as measured by the Brazelton Scale [1]. Their sample consisted of 33 clinically normal Navajo newborns and of 113 Malaysian neonates that included Chinese, Malay and Tamil infants. In their Navajo sample, the authors found highly significant correlations between the infants' peak of excitement, rapidity of build-up, irritability and lability of states and mean maternal arterial pressures (MAP) during the second trimester of gestation (range: 0.60—0.73) and mostly

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borderline significant correlations with MAP, 24 hours before delivery (range: 0.29—0.45). In their Malaysian sample, they found lower-order, though significant, correlations between maternal MAP during the first stage of labor and the percentage of time the infants cried and changed states during the Brazelton Examination (range: 0.22—0.23, $P < 0.05$). In a later paper, Woodson et al. [8] reported that they were unable to replicate their finding with a sample of primiparous English women. However, they mentioned, referring to their Navajo sample, that higher maternal blood pressure during the second trimester were associated with lower infant birth weights. In their second paper, the authors reported that relative fetal growth retardation, as calculated from published values and the infants' birth weights, was found in newborns of women whose peak antenatal blood pressure occurred during the second trimester of gestation. They also reported that lower fetal heart rates during labor were associated with higher infant irritability during two postnatal days.

The present study was designed to assess to what extent the authors' findings could be replicated with a white, American middle-class population. We also asked whether or not the authors' results generalized to different measures of infant irritability and arousal. Using the Brazelton Scale, Chisholm et al. [4] measured *elicited* infant irritability, whereas, in our study, we took behavioral measures of *spontaneous* infant irritability and arousal. Specifically, our study addressed the following questions: Is there a relation between mean maternal blood pressures during the second and third trimester and at delivery and duration of infant crying, infant activity, and infant birth weights? Also, is there a relation between the lowest fetal heart rates during labor and delivery and postnatal crying? Further, is there a relation between maternal and infant arousal as expressed in mean maternal and mean fetal heart rates during labor and delivery?

SAMPLE

The sample consisted of 70 Caucasian mothers and infants. Infant birth weights ranged between 2665 and 4196 g with a mean of 3479 g. Thirty-two were male, 38 were female. To insure the normality of the subjects, stringent selection criteria were used. These were: maternal analgesic drug intake less than 200 mg, 6 hours prior to delivery; duration of first and second stages of labor combined between 3 and 20 hours, followed by spontaneous or low forceps delivery from vertex presentation; Apgar scores of 8 or above at 1 minute; normal prenatal course uncomplicated by any maternal pathology; perinatal and postnatal status free of signs of anoxia, injury, anomalies or any other complications.

All mothers were normotensive throughout pregnancy. None had systolic pressures above 140. With one exception, none had diastolic pressures above 90. (One mother had a diastolic pressure of 94 on 1 out of 7 readings during the third trimester.) Mean arterial pressure was calculated using

the following formula: MAP = $\frac{(2 \times \text{diastolic} + \text{systolic})}{3}$ [3]. Second-trimester MAP was 82 ± 6; third-trimester MAP was 83 ± 6. Mean and lowest fetal heart rates at delivery were within normal limits (138 ± 6 and 124 ± 12, respectively). During delivery, 2 infants had a heart rate of 80 on one of many recordings. Mean maternal heart rate at delivery was 83 ± 11.

PROCEDURE

The infants' crying and activity were recorded for 1—3 days by an electronic activity monitor that was developed in our laboratory [5,6]. As soon as informed consent had been obtained from the parents, the infant was placed on a specially built foam rubber mattress connected to the electronic processing equipment that sensed the infant's movements without anything being attached to his body. A uni-directional microphone was used that switched on a timer at a threshold level which effectively screened out crying of other babies without missing true crying vocalizations of the subject. The monitor can record crying time, attendance time, frequency of total, non-crying and crying movements, median amplitudes of crying, non-crying and total movements and the duration and distribution of active and quiescent periods. For the purposes of this study, only 3 measures were used, all of which were highly reliable and had very high day-to-day stability [7]. These were day-time crying and two activity measures that were least confounded by crying, namely non-crying activity and amplitude of movements during non-crying periods. As data from the largest number of babies were available on the second day of life, we chose the data from that day to correlate with the prenatal and perinatal variables. Since only half the sample had prenatal visits during the first trimester of pregnancy, the blood pressure values from that period were not included in any of the analyses. The number of subjects in each statistical analysis comprised that subset of 70 having no missing data. This number varied from 51 to 69.

RESULTS

Table I shows the correlations obtained between the activity and crying measures and MAP during the second and third trimester and at delivery.

As can be seen, only one of the 9 correlations was highly significant, namely between third-trimester MAP and infant crying. None of the activity measures were significantly related to MAP during gestation or delivery. The infants' birth weights bore no relation to MAP during either the second or the third trimester of pregnancy.

In order to test whether the significant relation between crying and the third-trimester MAP was induced by other prenatal or perinatal factors, a

TABLE I

Spearman correlations between maternal blood pressures and infant variables (n = 51—69)

Infant variables	Maternal variables		
	MAP, 2nd trimester	MAP, 3rd trimester	MAP at delivery
Day-time crying	0.10	0.36*	0.13
Non-crying activity	0.09	0.10	0.20
Amplitude of movements (non-cry)	0.11	0.11	0.02
Birth weight	0.17	0.03	—

*$P < 0.01$.

multiple regression analysis was done with the following variables being considered: second- and third-trimester MAP, sex and weight of the infants, length of first and second stages of labor combined, analgesic drugs during labor, parity and maternal age. Since all the mothers had anesthesia during delivery, this variable was not entered into the multiple regression analysis. The multiple correlation coefficient between infant crying and these 8 factors (multiple $r = 0.40$, $P < 0.02$, $n = 48$) was accounted for almost exclusively by the correlation between maternal MAP in the third trimester of pregnancy and crying ($r = 0.33$, $t_{46} = 2.37$, $P < 0.02$).

We were unable to replicate the significant correlation between lowest fetal heart rates during labor and delivery and duration of infant crying reported by Woodson et al. [8]. Our correlation was 0.14, NS. Also, maternal arousal during labor and delivery as expressed in mean maternal heart rate bore no relation to mean fetal heart rates during labor and delivery ($r = 0.02$).

DISCUSSION

In their papers, Chisholm et al. [4] and Woodson et al. [8] have made a contribution to the field of prenatal influences on newborn behavior, a field in which relatively little solid research evidence exists. Because of the importance of this area of research, it is essential that some of the authors' findings be independently tested. The present study addressed the question whether or not Chisholm et al.'s finding of a significant positive relation between infant irritability and maternal blood pressures could be replicated with a different population and with different easures of infant irritability. Using samples of Navajo and Malaysian newborns, Chisholm et al. found a significant positive relation between newborn irritability in response to the Brazelton Scale and normotensive maternal blood pressures during the second trimester and during labor, respectively. Using a white, middle-class American population, we found a significant positive correlation between newborn spontaneous irritability, as measured by an electronic activity monitor, and normotensive maternal blood pressures during the

third trimester. Taking the results of these 3 studies together, it seems that maternal blood pressure in the latter part of pregnancy, even within normal limits, is significantly related to how irritable normal newborn infants are.

Failing to replicate the relation between maternal blood pressures and infant irritability with a sample of primiparous English women, Woodson et al. [8] proposed a model that hypothesized the existence of fetal mediators that could explain the relationship between increased maternal blood pressure and newborn irritability (chain of events: elevated third-quarter blood pressure→impaired fetal growth→lower fetal heart rates→poor infant condition at delivery and/or greater infant irritability). With our data, we could address only certain aspects of this model. We did not test the relation between the lowest fetal heart rates and Apgar scores, as none of our infants had Apgars below 8. We were unable to replicate the relation between the lowest fetal heart rates during delivery and duration of infant crying. Perhaps this was true because this relation is inherently not strong (Woodson et al. reported product–moment correlations of −0.21 and −0.22, significant at $P < 0.05$, using only one-tailed probabilities). We were also unable to replicate the significant relation between infant birth weight and maternal blood pressures during the second trimester reported in Woodson et al.'s paper [8, p. 129]. Both our sample and the sample discussed in the Woodson report included only infants whose birth weights were within normal limits. In pathological cases, however, evidence is accumulating that some of the fetal mediators between elevated pregnancy blood pressures and newborn irritability, as described by Woodson et al., may pertain. Growth-retarded, small-for-dates infants, who are often the product of hypertensive toxemic mothers, are frequently extremely irritable babies [2]. Perhaps the theoretical model proposed by Woodson et al. would more easily be verifiable with a population that included borderline hypertensive mothers and low-weight infants who, during delivery, had more frequent and more severe episodes of bradycardia.

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