THE RELATIONSHIP OF MATERNAL CATECHOLAMINES 
STRESS AND FETAL HEMEOSTASIS

Introduction

Mental stress and anxiety have long been known to affect many bodily functions. Psychologic stress produces a marked increase in catecholamine release from the adrenal medulla, increased sympathetic nervous system activity, and changes in circulating levels of adrenocortical and other hormones.

The early psychosomatic literature suggests that epinephrine is elaborated during fear, whereas norepinephrine is elaborated during anger (Funkenstein, 1956). More recently, Frankenhaeuser (1975) suggests that the epinephrine level increases under circumstances of novelty, anticipation, unpredictability, and general emotional arousal, whereas the level of norepinephrine increases during increased physical activity. InDimsdale's study (1980) reported that while exercise induces a response of the sympathetic nervous system, psychological stress induces primarily an adrenal response.

Pregnancy is a crisis period of major importance to women and their families. Some degree of anxiety is present during pregnancy progresses. Anxiety during pregnancy has been related to age, parity, general education, weight gain, and trimester of pregnancy. (Friederich, 1977). Maternal anxiety has been implicated as one variable in the etiology of maternal and fetal complications. Anxiety in pregnancy women has been associated with hyperemesis gravidarum, difficult and prolonged labor and habitual abortion (Myers, 1979). Fetal compli-
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cations related to maternal anxiety include prematurity, congenital deformity, mental retardation, low birth weight, and still-birth (Burstein, 1974).

With this in mind, I have chosen to explore "the relationship of maternal catecholamines, anxiety, and fetal homeostasis." How does maternal fear or stress influence the fetus? How should we intervene? The purpose of this paper is to review the adrenoreceptor theory, the effect of catecholamines, to propose implications for nursing practice, and to suggest further nursing research.

Adrenoreceptor theory

The effect of catecholamines depends on which adrenergic receptors are stimulated. There are two types of receptors in the body: alpha adrenergic receptors and beta adrenergic receptors. When primarily alpha adrenergic receptors are stimulated, this will cause vasoconstriction of all the blood vessels in the body, including the uterine vessels. Alpha stimulation will also cause an increase in uterine muscle tone, or uterine contration. The net effect of alpha adrenergic stimulation would include: 1) an increase in blood pressure because of the constriction, and 2) a decrease in uterine blood flow because of the constriction of the uterine blood vessels, and the increase in uterine tone.

Stimulation of beta adrenergic receptors will cause vasodilatation of most vascular beds in the body, with the exception of the uterine vascular bed. The uterine vascular bed is normally maximally vasodilated so that any further attempt to vasodilate it will be unsuccessful. Beta stimulation will also cause a relaxation of uterine
muscle. The net effect of beta adrenergic stimulation is a fall in blood pressure, a fall in uterine blood flow, and a relaxation of uterine muscle.

The primary catecholamines in the body are epinephrine, adrenaline, and norepinephrine. These have effects on both alpha and beta receptors. Norepinephrine affects mostly alpha adrenergic receptors, causing vasoconstriction and increased uterine tone. Epinephrine stimulates both alpha and beta receptors. In very low doses, epinephrine is primarily a beta stimulator. In higher doses, it is primarily an alpha stimulator. However the net effect of epinephrine is the stimulation of both types of receptors.

Epinephrine has one other effect: that is on uterine muscle. Very dilute solutions of epinephrine are beta stimulators. Beta stimulation causes relaxation of uterine muscle. In a double blind study of approximately 2000 patients having caudal anesthesia with or without epinephrine added, it was found that the first stage of labor was prolonged when epinephrine was used, compared to no epinephrine. More significantly, oxytocin stimulation of contractions was needed about twice as often when epinephrine was added to local anesthetic solutions. (Gunther, 1972).

Another effect of sympathomimetic amines is that of increasing uterine tone by alpha stimulation. Vasopressors with primarily peripheral action—such as mephathoxamine (Vasoxy) or phenylephrine (Neosynephrine)—may be harmful to the fetus because they produce further uterine vasoconstriction. (Clark, 1981). That could lead to fetal hypoxia and acidosis. This problem can be avoided by using vasopressors, such as ephedrine...
and mephentermine (Wyamine). These drugs have little alpha adrenergic activity. However, studies in pregnant sheep made hypotensive with spinal anesthesia show that epinephrine and mephentermine, both primarily centrally acting vasopressors, returned uterine blood flow toward control while restoring maternal arterial blood pressure. Fetal deterioration is, in fact, arrested and often reversed (Schnider, 1979).

**Literature Review**

**Recent animal studies:**

One category of related research involves animal experiments to determine the effects of maternal anxiety or catecholamine administration on the fetus. Ewes, guinea pigs, rabbits, and monkeys, have been used by various researchers (Adamsons, 1971; Artal, 1979; Clapp, 1979; Craft, 1983; Lederman, 1976; Schnider, 1979; Wallis, 1976). For the most part, the experiments involved catecholamine measurement of fetal heart rate, blood pressure, and blood gases.

Adamsons and coworkers (1971) reported that administration of catecholamines to the pregnant rhesus monkey near term resulted in fetal hypoxia and acidosis, followed by changes in the fetal heart rate, blood pressure, and electrocardiogram. Schnider, (1979) concluded that maternal stress (in 18 awake pregnant ewes) may decrease uterine blood flow secondary to release of endogenous norepinephrine. And, from Lederman's study (1978), it is evidence that during the period of ovine pregnancy investigated, the vascular beds of all tissues comprisory
the pregnant uterus, including the placental cotyledons, are sensitive to the vasoconstrictive effects of epinephrine. Artal, (1979) found that a significant rise in maternal and fetal catecholamines was observed following an estimated maternal blood volume depletion of 30%. During 15-minute recovery period, the maternal catecholamine concentrations returned to normal, while the fetal concentrations remained elevated. These changes were accompanied by significant changes in maternal and fetal homeostasis. These studies concluded that anxiety increases catecholamine levels. Also, increased levels of maternal catecholamines are associated with decreased uterine blood flow and deleterious fetal effects. The fetal response was due to decreased uterine blood flow and consequent fetal asphyxia. Other animal study using rats have shown that greater levels of conditional stress in pregnancy are associated with more emotionality, lower birth weights, and death in the offspring (Shabanah, 1971).

**Human studies:**

**Endogenous catecholamines and maternal response:** Recently it has become possible to measure catecholamines in human. Huber (1977) compared plasma epinephrine and norepinephrine concentrations during labor and immediately after delivery to those of the third trimester in 21 uncomplicated pregnancies of married primigravid women. Third trimester catecholamine concentrations were similar to those of normal, nonpregnant subjects. Compared to third-trimester levels, significant elevations of plasma epinephrine and norepinephrine were found in three phases of labor (at 3 to 5 cm and 9 to 10 cm of cervical dilation and immediately after delivery). Epinephrine values were elevated after completion of labor or during induction of labor. These changes may be a result of emotional stress, hormonal changes, or other factors.

Some studies have shown that increased catecholamine levels during labor may contribute to the development of clinical complications. Komissar et al. (1978) suggested that maternal catecholamine levels may influence uterine blood flow. Other animal studies have shown that greater levels of conditional stress in pregnancy are associated with more emotionality, lower birth weights, and death in the offspring (Shabanah, 1971).
values returned to normal within three to 21 minutes after delivery; norepinephrine values remained high or continued to rise in this time interval. The decrease of epinephrine immediately after delivery may reflect a reduction of emotional stress concomitant with delivery.

Dr. Lederman (1978) and her group have published some very interesting studies on catecholamines changes during pregnancy, labor and delivery. The relationship among maternal anxiety, selected stress-related biochemical factors, and progress in three defined phases of labor were determined for 32 married, primigravid women. Comparisons of plasma epinephrine, norepinephrine, and cortisol in the third-trimester of pregnancy, during labor, and after delivery are provided. At the onset of phase 2 of labor (3 cm of cervical dilatation), self-reported anxiety and endogenous plasma epinephrine are significantly correlated. With the deletion of subjects to control for the effect of medications, higher epinephrine levels are significantly associated with lower uterine contractile activity at the onset of phase 2 and with longer labor in phase 2. The relationship between epinephrine and progress in labor is explained by an adrenoreceptor theory. The human uterus at term has alpha- and beta-receptors. However, based on pharmacologic data, it displays greater sensitivity to epinephrine and other beta-arenomimetic drugs than to drugs that bind preferentially to alpha-receptors. Pharmacologically, epinephrine has been associated with lower uterine contractility, and norepinephrine with increased uterine contractility. The data in the Lederman's study show that, with the control for medications, physiologic elevations of plasma epinephrine are associated with...
lower uterine activity and also with a longer duration of labor in phase 2.

Influences of maternal catecholamines on fetus: The fetal heart rate pattern during labor has been reported to be related to infant development in the first year of life (Painter, 1978). The epinephrine level is known to be highly responsive to stress. Lederman and associates (1981) found that anxiety in labor and plasma epinephrine were significantly correlated with the fetal heart rate pattern in active phase labor (3 to 10 cm of cervical dilatation). The fetal heart rate pattern was significantly correlated with Apgar scores at 1 and 5 minutes. Conflict in the acceptance of pregnancy predicted anxiety and epinephrine levels in labor and the 5-minute Apgar score.

Crandon (1979) found a significantly higher incidence of fetal distress and lower Apgar scores for newborn infants of mothers classified as highly anxious in third-trimester pregnancy. In Gorsuch's (1974) study, investigator have found a significantly higher incidence of fetal asphyxia; congenital anomalies, stillbirths, and neonatal deaths among infants of women rated as having high levels of anxiety or stress during pregnancy as compared to control groups. In a retrospective study, Morgan and associates (1976) reported significantly greater prenatal stress in mothers who delivered premature infants with hyaline membrane disease than in a control group who delivered normal, fullterm infants.

While one researcher found no relationship (Burststein, 1974), another reported a significant negative correlation between maternal anxiety during pregnancy and infant birthweight (Shaw, 1970).
Influences of exogenous catecholamines: In addition to the mother's own catecholamines, which probably deleteriously affect the fetus, exogenous epinephrine administration in labor has been observed to result in decreased uterine activity. It has also been observed to result in fetal heart rate deceleration, attributable to arterial vasoconstriction and decreased blood flow and oxygen transport to the fetus (Marshall, 1979). In Kang's study (1982) suggest that prophylactic ephedrine infusion is safe and desirable in healthy parturients undergoing Cesarean Section under spinal anesthesia.

Implication for nursing

The literature review provides evidence that anxiety can increase maternal catecholamines. Catecholamines have the potential to deleteriously affect the mother and the fetus, including: lower uterine contraction, prolonged labor, fetal asphyxia, neonatal abnormalities, infant low birthweight. Considering the variability of research on maternal catecholamines, anxiety and fetal homeostasis, several recommendations for nursing practice are appropriate.

Reducing maternal anxiety in pregnancy:

Identification: Careful investigation of the patient's social history, health history, are important in identifying stressful situations. Those involved in providing maternity care should be aware of the physical manifestations of anxiety. One such group would be women with high-risk pregnancies: women with diabetes, preeclampsia, hypertension, heart disease, Rh sensitization, or poor
triestric histories. The fetuses of these women are those least able to tolerate any decrease in uterine blood flow or any other kind stress.

Parent education classes: As well as providing realistic information about pregnancy and child-birth, these classes teach women the concept that they may have some measure of control over what happens to them. Unfortunately, the economically and educationally disadvantaged, who are most in need of this kind program, are often left out. Groups involved in supporting prepared childbirth and parent education must press for more programs to reach all segments of the population. It would also be helpful if classes were offered earlier in pregnancy.

In Lederman's study (1979), the two most common concerns reported by more than 90% of the pregnant women related to the baby's health and normalcy, nurses have the responsibility to reduce or alleviate concerns of this nature. Nurses can teach pregnant women about normal fetal growth and development. They should keep patients informed about fetal progress and continued growth by discussing fundal height measurements, fetal heart rates, and weight gain at each visit. A pregnant woman may have less concern about her baby's health and normalcy if she makes a graph of her own weight gain and compares it to the expected weight gain. In this way, a pregnant woman can appreciate growth of the fetus, and this knowledge may reassure the woman of her baby's health.

In prenatal classes as well as in individual sessions with patients, nurses should discuss and teach topics that pregnant women identified as concerns during each trimester of pregnancy. During the first trimester,
trimester, nursing care should focus on the pregnant woman, with less emphasis on the fetus. It is important to continue to focus on the pregnant woman as well as her baby during the second and third trimester. Because pregnant women have the most concerns in the third trimester, nurses should arrange for additional time to discuss certain points and anxiety in the last few months of pregnancy. Individual counseling would help reduce anxiety levels. On the other hand, if concerns are appropriately discussed during the first and second trimester, there may be less need to provide additional time with women in the third trimester.

Reducing maternal anxiety and pain in labor and delivery:

There are many nonpharmacologic techniques for stress and pain relief.

Giving information: The nurse may tell the mother approximately how long it will be before the next contraction and how long that contraction will last. Information about the progress of labor, such as cervical dilatation and descent of the baby, is also important. Such information not only reduces anxiety but may also motivate the mother to tolerate pain.

Decreasing sources of noxious stimuli: One source of noxious, or painful, stimuli is abdominal pressure on the contracting uterus. Pressure may be prevented by either abdominal breathing or chest breathing. Another obvious method of reducing abdominal pressure is simply to lift the abdominal wall.

Distraction: The nurse needs to be familiar with a variety of distracters that she may suggest to the mother. What is sufficiently distracting for one mother may
not be another. And a mother may need assistance with
distracters even if she has attended classes in a method
of prepared childbirth.

**Cutaneous stimulation:** Rubbing a painful body part
is a universal means of relieving pain. Rubbing the
lower back is common.

**Relaxation:** Both a big sign (deep breath) and a
yawn are associated with relaxation.

**Support system:** Sosa (1980) reported that mothers
who were quiet and relaxed and better emotional relations
with their attendants during labor, delivery were more
pleased at the first sight of their babies. It is necessary
to develop an adequate health care providers.

**Control:** Rich (1973) stated that every woman expects
to have a degree of ego control during labor. Butani
and Hodnett (1980) found that 39 of 50 subjects cited
aspects of control as important to them during labor.
Highly and Mercer (1978) suggested that nursing interven­
tions to assist a laboring woman to maintain control
should include allowing her decision-making power over
aspects of her environment.

However, when nonpharmacologic techniques have
not been effective, skillful anesthesia, coupled with
reassurance and emotional support, may make birth less
stressful not only for the mother but also for the fetus.

Shnider (1983) studied the effects of epidural
anesthesia during labor on maternal circulating catecho­
lamines. Lumbar epidural anesthesia during labor reduces
maternal epinephrine levels, probably by eliminating
the psychological and physical stress associated with
painful uterine contractions or by denervating the adrenal
medulla. Whatever the mechanism, reducing pain and acti-
vity of the sympathetic nervous system by continuous epidural anesthesia should increase uterine blood flow.

In conclusion, intervention measures to reduce anxiety, must be made available to make pregnancy and childbirth a more positive experience for the mother and family; to improve the patient's cooperation in her pregnancy and childbirth care; to reduce the need for analgesic medications in labor; and to prevent the prolongation of labor which may result when a woman is too tense and anxious.

Suggestion of further nursing research

Because methods for sensitive and accurate measurements of stress-related biochemical measures and uterine activity have recently been developed, research can now address questions concerning the important psychological variables in pregnancy and the physiological mechanisms by which conflict and anxiety might influence uterine activity and progress in labor.

In current animal and human studies (Adamsons, 1971; Artal, 1979; Clapp, 1979; Craft, 1983; Huber, 1977; Lederman, 1976, 1978; Shnider, 1979; Wallis, 1976), epinephrine, norepinephrine, and cortisol are recognized as stress-related biochemical measures. There is also evidence to suggest that epinephrine, as well as other beta-sympathomimetic agents, inhibit uterine motility, that norepinephrine is associated with increased or incoordinate uterine activity, and that cortisol levels correlate with the length of labor.

Several recommendations for further nursing research are appropriate, as follow:
1). Further research should consider the relationships between psychological variables in pregnancy and progress in labor with both primigravidas and multigravidas.

2). Further research should also consider the effects of maternal anxiety on the fetus and neonate, as well as on the postpartal maternal psychological state and the mother-child relationship.

3). Further research need to determine effectiveness of planned programs of intervention on pregnancy and in labor, such as: early identification of psychological conflict and anxiety in pregnancy and appropriate therapeutic intervention, methods of reducing maternal anxiety and pain in labor and delivery.
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