BIOLOGY

Fighting the crushing pressures of birth

Fetus endures more stress than an adult heart attack

By Margie Patlak
SPECIAL TO THE EXAMINER

ONCE A MYSTERIOUS combination of hormones prompts labor, and the muscles surrounding the uterus begin the rhythmic contractions of birth, the ordeal a human infant goes through is gruelling enough to break an arm or a leg.

The pressure in the uterus may shoot as high as 2 pounds per square inch as the baby pushes downward through the birth canal, and each contraction squeezes the life-sustaining placenta and umbilical cord that attach the baby to the mother's oxygen supply. With each crushing contraction, that supply is temporarily cut off, putting the baby under more physical stress than is experienced by a full-grown person having a heart attack.

Fortunately for the fetus, however, it is generally protected from harm during delivery by a surge of its own "stress hormones" that, through a number of exquisitely coordinated actions, minimize its need for oxygen. These hormones, called catecholamines, also boost the infant's chance of survival once it emerges from the womb by speeding the changes in the lungs necessary for proper breathing.

Recent research on catecholamines, which triple in concentration in the blood of the fetus during labor, indicates an infant delivered by Caesarean section is at a distinct disadvantage without them. And, some researchers now believe that the irregular heartbeat of a fetus, which doctors traditionally interpret as signaling a needed Caesarean section, may actually show that these protective hormones are hard at work.

The two major hormones that comprise catecholamines, epinephrine and norepinephrine, are known as "fight or flight" hormones because they enable the body to fight or flee from threatening situations. High levels of catecholamines in an adult animal, for exam-

— See BIRTH, E-4

Examiner file photo

BIRTH

—From E-1

ple, make its heart beat faster and selectively dilate or constrict its blood vessels so that during a threat such as a predator attack, blood is shunted away from nonessential organs like the skin and intestines and propelled toward more crucial organs like the heart, brain and muscles.

These responses, combined with the rapid conversion of stored carbohydrates into usable fuels (also prompted by the hormones), provide the animal with a surge of energy and oxygen necessary for a quick escape or a forceful fight.

The fetus, unlike an adult, cannot flee. Instead it must be able to withstand the primary threat to its survival — suffocating conditions in the womb.

According to the National Institute of Child Health and Human Development, 30 percent of stillbirths and newborn deaths are due to lack of oxygen during labor and delivery. Such a lack of oxygen is also thought to be the cause of 20 to 40 percent of all cerebral palsy and 10 percent of severe mental retardation.

Dr. Theodore A. Slotkin, professor of pharmacology and psychiatry at Duke University in Durham, N. C.,and other researchers have shown that the human fetus' unique anatomy and metabolism enables it to withstand a lack of oxygen for as long as 10 minutes — four times longer than the average adult — before suffering brain damage. "The various adaptations in fetal physiology are Mother Nature's response to the birth process," Slotkin says.

Studies have shown, for example, that the human fetus generates more norepinephrine than epinephrine in response to stress. Norepinephrine slows the heartbeat and reduces the heart's need for oxygen. The fetus also can generate more norepinephrine than the adult because of extra norepinephrine production sites in tissues that disappear during childhood.

As an additional safeguard, higher levels of epinephrine are needed to prompt the fetal heart, as opposed to the adult heart, to beat faster. To verify the importance of norepinephrine in protecting fetuses from suffocation, Slotkin and his colleagues used drugs to block the effects of catecholamines in sheep fetuses. The animals died when they were subsequently deprived of oxygen.

Each time the uterus contracts it compresses the placenta and umbilical cord, stemming the flow of oxygen to the fetus. The fetus responds by increasing its secretion of catecholamines.

Animal studies show that the pressure on the head during uterine contractions can stimulate increased secretion of catecholamines by triggering the nerve in the brain that connects to catecholamine production sites. Such pressure on the head generally is not dangerous to the baby because the bony plates that comprise its skull slide slightly over one another.

The importance of labor in prompting catecholamine secretion is supported by the findings of Dr. Hugo Lagercrantz and his colleagues at the Karolinska Institute in Stockholm, Sweden.

These researchers discovered that infants delivered by Caesarean section without labor had significantly lower levels of catecholamines than those delivered by Caesarean section after labor had begun.

Other studies by Dr. Raul Artal, associate professor of obstetrics and gynecology at the University of Southern California in Los Angeles, reveal that at the beginning of a normal delivery, catecholamine concentrations in fetal scalp blood samples are about five times as high as the concentrations in a resting adult, and by birth the hormone levels double or triple again.

The surge of fetal stress hormones during labor can frequently cause an irregular heartbeat that might be misinterpreted as life-threatening fetal distress requiring immediate delivery by Caesarean section. Such misinterpretation might explain, in part, the dramatic rise in the number of Caesarean sections performed in recent years.

When complex heart changes are found during contractions, the fetus is frequently assumed to be suffering from a life-threatening lack of oxygen and is delivered surgically. But some studies reveal that on surgical delivery, more than 50 percent of infants show no signs of extreme lack of oxygen.

After an infant is delivered, it usually takes about two hours before its catecholamine levels return to resting levels.

During that time, the hormones enhance the infant's survival by speeding the changes needed in the lungs for proper breathing; infants delivered by elective Caesarean section are much more likely to have breathing difficulties than babies vaginally delivered. These difficulties are primarily caused when fluid present in the lungs at birth is inadequately absorbed, or when a soap-like substance called surfactant (which coats the air sacs in the lungs, enabling them to open) is not produced in sufficient quantities.

The absorption of lung liquid and the release of surfactant both appear to depend to some extent on the rise in catecholamine secretion in the hours immediately before birth.

Animal studies support this hypothesis. When scientists at the University College in London injected fetal sheep at term with epinephrine, the liquid in their lungs was absorbed immediately.