Perinatology

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Perinatology is the clinical specialty which focuses on the fetus during the end of gestation, birth, and the initial neonatal period. In our clinic perinatology encompasses the care of high-risk pregnancy patients, high-risk births, and initial therapy for the neonate through the transition of birth and adaptation to neonatal life. Although our original efforts were primarily directed towards the equine, over the years we have adapted similar techniques to the other farm animal species depending on their economic and emotional value.

Gravid dams are considered at high-risk when they've had a history of problems during past pregnancies or have developed a new problem during the current pregnancy. Rather than focusing on the mare's problem I find it more useful to think of the mare's problem in terms of how it threatens fetal or neonatal well-being. After understanding the threat, then a plan to try to minimize or eliminate the threat can be made and carried out.

It is important to remember that the fetus must get everything from the mother and the mother has total control of the fetal environment. There are no known means for the fetus to directly communicate its changing needs to the dam. Despite this, the fetus does have some ability to compensate for changes brought about because of disturbances in maternal homeostasis. Threats to fetal well-being can be considered in the following categories: lack of placental perfusion, lack of oxygen delivery, nutritional threats, placentitis/placental dysfunction, loss of fetal/maternal coordination of maturation, interaction with other fetuses (multiple pregnancy) and iatrogenic factors (drugs or other substances given to the mother, early termination of pregnancy e.g. induction).

Many fetal problems may go undetected, so the gestation which appeared to be normal may result in an abnormal neonate.

Lack of placental perfusion: Cardiac output during pregnancy increases 30 to 50%. About half of this increase goes to the uterus and the rest to other areas to compensate for the increased demands of pregnancy. During the last trimester there's a dramatic increase in blood flow to the placenta in parallel with fetal growth. The late term fetus has a very high oxygen demand and must have a high rate of placental perfusion from the mother to receive a constant flow of enough oxygen. Unfortunately oxygen cannot be stored so there can be only short term compensation (through redistribution of fetal blood flow) for poor placental perfusion. The margin of safety in late pregnancy is small. There are many maternal problems which occur in late pregnancy that may decrease maternal systemic perfusion. Thus whenever maternal perfusion is compromised and there is an insufficient maternal systemic compensatory response, placental circulation and oxygen delivery to the fetus may be compromised resulting in a significant threat to the fetus. Because of this, maternal hypovolemia must be treated aggressively. If pressors are used, they should be used with care.

Lack of oxygen delivery to the fetus: Although a major reason for the lack of oxygen delivery to the fetus is decreased placental perfusion, maternal anemia and maternal hypoxemia may also be involved. Survival of the fetus depends on efficient oxygen transport which is determined by unique aspects of placentation or placental oxygen transport mechanisms. Placental gas transport is thought to be independent of diffusion and completely flow dependent. That is, there is no significant loss of transport in the face of a diffusion barrier. Rather, the pattern of flow of maternal and fetal blood determines the efficacy of gas transport.

Although functionally all placentas are the same, physically there's almost as many different placental patterns has there are species. This is especially true in

the alignment of maternal and fetal circulation. When looked at histologically, often there appears to be an attempt to alignment fetal and maternal vessels so that the blood flow pattern fits a countercurrent flow pattern (the vessels are parallel to each other and the flows are opposite). This is the most efficient pattern for transfer of oxygen and nutrients and getting rid of waste products. With this pattern the venous side of the fetal capillary bed is aligned with the arterial side of the maternal capillary bed so that the gradient of oxygen and other nutrients is the highest possible. This pattern is almost realized in the equine placenta. This efficient arrangement of blood flow patterns in the horse has some important implications in transport mechanisms and adaptive processes.

Because of the countercurrent circulatory pattern, the gradient between maternal and fetal blood O_2 and CO_2 are different in the fetal foal compared to other farm animals. In most species (sheep, cows, pigs) the difference between uterine vein and umbilical vein P_{O2} is 20 torr resulting in an umbilical venous P_{O2} of 30-34 torr in the fetal sheep. However in the horse, this gradient is near 0 torr resulting in an umbilical venous P_{O2} of 48-54 torr. Likewise, in most farm animal species the difference between uterine vein and umbilical vein P_{CO2} is 4-5 torr. In the horse, this gradient is again near 0 torr. These differences have some important clinical implications. In most species, changes in maternal P_{aO2} do not significantly change fetal values since the gradient is heavily influenced by the venous side of the maternal circulation which is relatively stable under these circumstances until extreme changes occur. However, the fetal foal is heavily influenced by changes in maternal P_{aO2}. For reasons that are not completely clear, in the face of maternal hypoxia, the fetal foal's umbilical P_{O2} is 5-10 torr < uterine vein P_{vO2}. Thus, maternal hypoxemia may have a profound effect on the fetal foal, perhaps another reason for the frequent finding of signs of hypoxic ischemic asphyxial

disease in the foal. On the other hand, when maternal P_{aO2} is increased with

inhaled oxygen, the umbilical P_{O2} rises higher than the uterine vein P_{vO2}. This is probably a matter of an increased driving force allowing more efficient transport. We have used this physiologic phenomenon to therapeutic advantage by supplementing pregnant mare's with intranasal oxygen when we have the clinical impression that the foal is suffering from significant hypoxemia. Of course this therapy in theory will only maximally benefit the fetal foal and perhaps the fetal kid while the other species we deal with will see less of a benefit.

Serious consideration should be given to blood transfusion therapy in anemic dams to prevent fetal hypoxemia. It should be understood, however, that giving blood transfusions to a brood mare may predispose her to produce antibodies against blood groups resulting in neonatal isoerythrolysis in future foals.

Nutritional Threats to Fetal Well-being: The mare's nutritional state may directly affect the fetal foal's well-being. Chronic malnutrition such as occurs with lack of intake (because of lack of opportunity), malabsorption, tumor cachexia and other conditions and acute fasting such as occurs when elective surgical procedures are performed, when the mare has colic during late term or merely because of a capricious appetite of the late gestational mare can have a negative effect on fetal well-being. After 30-48 hr. of complete fasting in the late term mare there is a decrease in glucose delivery and a rise in plasma free fatty acids. These changes are associated with an increase in prostaglandin production in both maternal and fetal placenta (maternal and fetal placenta and fetal fluids contained a complex mix of prostaglandins which seems to be important in maintaining pregnancy and may have a role in initiation of parturition). In fact when the late term mare is being fed concentrate feed there will be a very small fluctuation in prostaglandin production such that there will be peak production just before the mare is fed and a drop associated with feeding. For unknown reasons,

there is an increased risk of preterm delivery within one week of ending a complete fast. This is believed to be associated with the change in prostaglandin levels however the levels will have been normal for some time before delivery is initiated. The delivered foal often appears premature and not ready for birth. The likelihood of survival in these foals is small. Current theories suggest that the changes in prostaglandin production may lead to an increase in myometrial sensitivity to hormones leading to the increased risk of delivery.

For these reasons it is important to support the mare's nutritional needs as she reaches the end of gestation. The mare may need supplementation and may need to be encouraged to stay on a high plane of nutrition. Acute fasting should be avoided whenever possible by avoiding elective procedures requiring fasting. If the mare has to be fasted or becomes completely anorexic, intravenous glucose supplementation should be undertaken. Studies indicate that providing intravenous glucose in such cases will negate the changes in prostaglandins and probably greatly decrease the risk of early delivery. The glucose infusion does not need to meet the mare's caloric deficit, just suppress fat mobilization. When mares are periodically anorexic and encouraging them to continue to eat is difficult, placing them on flunixin meglumine in an attempt to prevent prostaglandin changes may also be rational.

Placentitis/placental dysfunction: There are a number of placental diseases seen in the late term mare including: premature placental separation, placental infection, non-infectious inflammation, placental degeneration, placental edema and hydrops allantois/amnion. Infectious placentitis is most commonly caused by ascending bacterial or fungal pathogens. It may also be caused by hematogenous spread of viral, bacterial, ehrlichial or fungal pathogens. On rare occasions we see what appears to be a non-infectious placentitis. Recently the hirsute (hairy) cuticle of the Eastern tent caterpillar has been implicated in causing physical injury to placental vessels resulting in significant placentitis and

fetal distress. It should be noted that the percentage of placenta affected is not a predictor of the outcome of the pregnancy. That is, a foal born with widespread placental lesions may no worse off than a foal with a focal placental lesion. It appears to the presence of placentitis, no matter how extensive is enough to predict a serious problem. There are much higher odds of the occurrence of Neonatal Syndrome (Neonatal Encephalopathy, Neonatal Nephropathy and/or Neonatal Gastroenteropathy) in foals born to mares with untreated placentitis.

Since most mares with placentitis have bacterial placentitis, all suspect cases should be treated as such until proven otherwise. The treatment I have found to work best over the years when a specific etiology has not yet been identified is the combination of an antimicrobial (specifically trimethoprim potentiated sulfa drugs), a NSAID (anti-prostaglandin) drug (flunixin meglumine) and hormone supplementation (altrenogest – which is also an anti-inflammatory). In a recent retrospective study we found that all 3 of these treatment modalities are important in preventing Neonatal Encephalopathy, Neonatal Nephropathy and/or Neonatal Gastroenteropathy in foals born to these mares.

Loss of Fetal/Maternal Coordination of Readiness for Birth: The normal timing of parturition is decided cooperatively by maternal, fetal and placental events. There is a dynamic interaction between these three distinct forces which coordinates the readiness for birth. The loss of coordination will result in premature, dysmature or postmature foals. Factors determining which occurs are discussed in detail in the hand out on "Prematurity, Dysmaturity and Postmaturity."

Iatrogenic Factors: There are a large number of possible iatrogenic factors that may threaten the well-being of the fetus. A major one is poor timing of induction of delivery. When the timing of induction is solely based on the calendar and convenience of the owner or veterinarian, the result is often disastrous. When

delivery is timed based on emergency considerations for the mare, equally unfortunate outcomes often occur. Many of the drugs mares receive affect the fetus in a variety of ways. Some such as tranquilizers and analgesics (detomidine, butorphanol) can have immediate and profound effects on the fetal cardiovascular system.

Presence of a Twin: The mare is somewhat unique in her inability to support multiple fetuses. At least to me, the reason for this is not entirely clear. Certainly the presence of a co-twin competes for uteroplacental attachment area, competes for nutrients and oxygen, competes for space and significantly increases the risk of dystocia.

Idiopathic Factors: Many foals born with Neonatal Syndrome have no history of abnormalities occurring during gestation or parturition. Certainly many events occur without our knowledge. Although it is attractive to blame problems during parturition, most these problems occur during the antepartum period.

Fetal Monitoring

Fetal monitoring has a long history in human medicine. Although initially used exclusively intrapartum, prepartum fetal measuring is now commonly performed in high-risk pregnancies in man. A collection of ultrasound arrived observations called a biophysical profile has been used to assess fetal health or distress. The equine biophysical profile (via ultrasound exam) consists of fetal heart rate, fetal aortic diameter, maximum fetal fluid depths, uteroplacental contact, uteroplacental thickness and fetal activity (subjective assessment with no clear objective criteria). This profile lacks sensitivity (a fetus with a normal profile may be suffering from a life-threatening problem) and specificity (occasional extreme values are found in normal fetuses e.g. bradycardia, placental separation). Its

overall utility is unproven. However the information gathered about the placenta in conjunction with other critical information can be quite valuable.

Fetal heart rate monitoring is another method of assessing the well-being of a fetus. Fetal heart rate can be measured via ultrasound or ECG. Although the ultrasound technique has been commonly utilized, since it only measures the rate by measuring the difference between two beats the result can be inaccurate. Also since long-term measurements are not usually made, it may be misleading.

When using an ECG to obtain fetal heart rate, any ECG machine with recording capabilities will work. Electrodes are placed at the lumbosacral junction and on both flanks and periodic recordings are made over a period of at least 10 minutes or telemetry is used to get sample readings 8 – 10 times during each 24 hr. period. Important fetal heart rate parameters to measure are the heart rate itself, the occurrence of accelerations in decelerations, the beat to beat variability, changes in the complex, presence of arrhythmias and the presence of more than 1 distinct pattern suggestive of a twin.