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Extrinsic Factors

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Definition: Factors in the fetal environment that affect the availability of oxygen and the ability to transport oxygen to the fetus, thus affecting the FHR (CPPC, 2009, p.23).

Baseline arterial oxygen tension of the gestational parent (CPPC, 2009, p. 23)

- Provides a source for O2 transported to and used by the fetus. These can be altered by:
    - **Acute maternal hypoxemia**
        - Compromises maternal arterial O2 saturation and tension, reduces O2 available to the fetus.
        - Maternal seizure, trauma, major hemorrhage.
    - **Acute or chronic maternal respiratory disease**
        - Reduces O2 saturation and results in compromised fetal or placental growth and development.
        - Pulmonary edema, asthma, pneumonia, bronchitis.
    - **Maternal Smoking**
        - Results in lower O2 saturation because carbon monoxide molecules displace O2 on hemoglobin, and vasoconstriction occurs due to nicotine.
        - Mothers who smoke are twice as likely to have low birth weight as mothers who do not.
    - **Maternal Hypoventilation**
        - Breath-holding or pushing techniques may transiently decrease the availability of O2.

Gestational parent oxygen-carrying capacity (CPPC, 2009, p. 23)

- Depends on sufficient available hemoglobin for transporting O2. Maternal blood volume increases by approximately 45% during pregnancy due to an increase in plasma volume and an increase in erythrocytes of approximately 30%.
    - **Maternal Anemia**
        - Due to iron deficiency, hemoglobinopathies or hemorrhage reduces available hemoglobin for O2 transport.
    - **Maternal Environment**
        - Women who live at higher elevations may have a fetus that is smaller in growth due to the decreased availability of oxygen in the air.

Uterine Blood Flow: (CPPC, 2009, p.23)

- Determines ultimate availability of O2 for placental profusion. Uterine blood flow is determined by maternal arterial blood pressure. Altered by:
    - **Supine Positioning**
        - Can significantly decrease uterine blood flow by decreasing venous return and uterine arterial blood flow.
    - **Maternal diseases and drugs**
        - They produce significant vasoconstriction (hypertension, bleeding/clotting disorders, use of cocaine in pregnancy, or administration of narcotics in labor.) and decrease uterine blood flow secondary to increased catecholamine release.
    - **Conduction anesthesia**
        - May cause systemic hypotension, which markedly decreases uterine arterial pressure and, therefore, uterine blood flow.
    - **Maternal Hyperventilation**
        - May increase catecholamine production, exaggerate the mild compensated respiratory alkalosis of pregnancy, and decrease uterine blood flow.

Uterine Contractions: (CPPC, 2009, p. 24)

- Uterine arteries and veins conducting maternal blood to and from the placenta pass through the myometrium and are, therefore, subject to compression during uterine contractions.
    - **During Labor**, oxygen/carbon dioxide exchange occurs primarily between uterine contractions when blood flow is unimpeded. Contractions decrease blood flow, increase the venous pressure in the uterus, and decrease uterine artery perfusion.
    - The **baseline tonus** is represented by intrauterine pressure between contractions. Pressures greater than 20-25mmHg are usually considered hypertonic.

Placental surface area: (CPPC, 2009, p. 25)

- The amount of **placental-fetal surface** available for exchange of nutrients, elimination of waste, and production of hormones, steroids, etc.
- **Functional PSA** available depends on adequate maternal nutrients and maternal-uterine blood flow. Adequate placental function provides for the transport of O2 to the fetus at levels above the fetus basal needs.
- Any **decrease in placental function** can impact on the fetal ability to withstand normal stresses of labor and birth. Intrinsic mechanisms may be unable to compensate for the normal degrees of hypoxia seen with uterine activity.
- **Reduction of amniotic fluid** volume may also be associated with compromised placental function, limiting protection of the fetus and umbilical cord.

- **Absent placental function results in intrauterine death.**

Placental Blood Flow: (CPPC, 2009, pp. 25-26)

- **Serves as the mechanism for fetal respiratory function.** Approximately 70-90% of uterine blood flow reaches the placenta, this percentage directly reflects the amount of O2 available for maternal-fetal exchange.
- **Substances cross the placenta by several mechanisms**: oxygen by simple passive diffusion at a rate directly proportional to the placental area and to differences in concentration on either side.
- **Fetal gas exchange** occurs in the placental villi contained within the cotyledons, and depends on the structural integrity of placenta and related blood flow . Integrity may be compromised by damage to the cotyledons as seen in maternal conditions such as inadequate nutrition, diabetes, smoking, or preeclampsia.
- **Placental seperation and structural abnormalities** may also compromise placental integrity and blood flow.

Umbilical Cord Influences: (CPPC, 2009, p. 26)

- Cord occlusion causes transient hypoxemia, unless it is prolonged or chronic. FHR responses to cord compression have been shown to vary significantly depending upon the degree of occlusion and resulting degree of reduction in blood flow.
    - **Partial intermittent cord occlusion**
        - Of only the umbilical vein, in the previously well-oxygenated fetus may produce decreased fetal cardiac output and BP, and sympathetic stimulation which results in an temporary increase in FHR. Preterm infants has other aspects such as decreased Whartons Jelly not protecting from cord compression as much.
            - Mechanical forces such as compression by fetal body parts or loops of cord coiled around portions of fetal body cause impaired blood flow. This occurs intermittently in the majority of labors.
    - **Complete or abrupt cord compression**
        - Results in an abrupt increase in fetal BP, which stimulates fetal baroreceptors and produces abrupt decrease in FHR Prolonged complete cord occlusion results in hypoxemia, chemoreceptor response, and an increasingly prolonged decrease in the FHR. If unresolved may result in extended hypoxia and acidosis.
            - Vascular abnormalities of the cord such as true knots, strictures or a two vessel cord may cause acute or chronic impairment in blood flow.

References

The Canadian Perinatal Programs Coalition. (2009). *Fundamentals of Fetal Health Surveillance: A Self-learning Manual*.