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Interpreting Umbilical Cord Blood Gases: Section 8: Low Apgar Scores Without Intrapartum Asphyxia

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Case 23: Asphyxia Prior to Hospital Admission

The mother was a 41-year-old, gravida 4, para 3, aborta 0, with an intrauterine pregnancy at 42 0/7 weeks gestation. (1) She complained of decreased fetal movement beginning the day before admission and felt no fetal movement on the morning of admission. At the hospital, she had uterine contractions every five to seven minutes; her cervix was five cm dilated, completely effaced, and at zero station. The FHR was 140 bpm, without decelerations but with absent variability. After one hour, the patient had an uncomplicated vaginal delivery of a male infant with Apgar scores of 3 and 6 at one and five minutes, respectively. Amniotic fluid was clear. The placenta was not sent to pathology.

Cord blood gas results were as follows:

	Umbilical Vein	Umbilical Artery
pH	7.35	7.31
Pco_2 (mmHg) ***(kPa)***	48 *6.40*	52 *6.93*
Po_2 (mmHg) ***(kPa)***	21 *2.80*	14 *1.87*
BD (mmol/L)	-1	0

Blood gases obtained from the infant at 30 minutes of age were as follows:

	CBG
pH	7.33
Pco_2 (mmHg) ***(kPa)***	42 *5.60*
Po_2 (mmHg) ***(kPa)***	41 *5.47*
BD (mmol/L)	4

The NRBC count was not elevated. Subsequently, the infant had a seizure in the neonatal intensive care unit and showed signs of moderate renal failure, from which he ultimately recovered.

Interpretation

Both the umbilical venous and arterial cord blood gas results are entirely normal. In the presence of FHR monitoring that continues until close to the time of delivery and in the absence of significant FHR decelerations, intrapartum fetal asphyxia can be excluded. However, in the presence of low Apgar scores, it is prudent to obtain a follow-up blood gas directly from the infant soon after birth to document the infant's blood gas status. One would expect complete cord occlusion (both venous and arterial), a complication that could explain normal or near-normal cord gas values, to have resulted in severe fetal bradycardia. However, bradycardia was not observed, and the follow-up capillary blood gas was normal. This infant was not suffering from asphyxia at the time of delivery.

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Intrapartum asphyxia is not the only cause of low Apgar scores. Another cause of Apgar score depression is recent *antenatal*, but not *intrapartum*, moderate to severe *in utero* asphyxia with acid-base recovery before delivery. Such a baby may have neurological findings during the neonatal period. This deficit would corre-

spond with the maternal history of decreased fetal movement and the absence of variability in an otherwise stable heart rate pattern. Usually, but not always, problems of uteroplacental insufficiency increase over time. Occasionally, uteroplacental insufficiency or a cord problem may injure the fetus, allowing fetal acid-base recovery before delivery.

In this case, the neonatal clinical course strongly suggests hypoxic-ischemic encephalopathy and acute tubular necrosis with recovery. The FHR tracing on the day of admission, the normal umbilical cord blood gas values, and the normal follow-up capillary blood gas shortly after delivery suggest the insult occurred before fetal monitoring was initiated. Absent variability on the fetal monitoring strip, right from the beginning of the tracing, confirms this. The absence of an elevation in the NRBC count (2) suggests the insult was relatively acute and was not ongoing during labor and delivery. It is highly unlikely that earlier delivery during fetal monitoring would have resulted in a baby with a different clinical course or a better outcome.

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Key Point

- Even in the presence of low Apgar scores, absence of significant decelerations on FHR monitoring, presence of normal or near-normal umbilical cord blood gas values, and a normal follow-up blood gas soon after delivery all suggest the absence of *intrapartum* asphyxia and likely recent *antepartum* asphyxia.

Case 24: Renal Agenesis with Hypoplastic Lungs

The mother was a 27-year-old, gravida 2, para 1, aborta 0, with an intrauterine pregnancy at 40 1/7 weeks gestation. (3) The mother reported spontaneous rupture of membranes five hours before admission with the escape of a small amount of clear fluid. The FHR monitor showed variable decelerations. Over the next several hours, the patient's cervix became completely dilated and effaced, and the head was at plus two station. The FHR monitor revealed deep variable decelerations that lasted 60-90 seconds. The infant was delivered vaginally 30 minutes later. Apgar scores were 2, 2, and 3 at one, five, and 10 minutes.

Cord blood gas results were as follows:

	Umbilical Vein	Umbilical Artery
pH	7.31	7.26
Pco_2 (mmHg) *(kPa)*	44 *5.87*	53 *7.07*
Po_2 (mmHg) *(kPa)*	19 *2.53*	14 *1.87*
BD (mmol/L)	4	3

A pediatric resuscitation team was present at the time of delivery. The infant was intubated and bag ventilated with 100% oxygen.

After 30 minutes, the infant's arterial blood gas results were:

	Infant's ABG
pH	6.92
Pco_2 (mmHg) *(kPa)*	87 *11.60*
Po_2 (mmHg) *(kPa)*	19 *2.53*
BD (mmol/L)	15

Interpretation

The normal umbilical cord blood gas results suggest that one can exclude intrapartum asphyxia as the cause of neonatal depression. However, complete cord occlusion should be considered, especially in light of the moderate to severe variable decelerations and the oligohydramnios suspected based on the mother's reporting only a scant amount of clear fluid.

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The follow-up blood gas at age 30 minutes demonstrates both respiratory and metabolic acidosis. The events that led up to this blood gas have many possible etiologies. The most likely ones include unilateral or bilateral pneumothorax, congenital diaphragmatic hernia, cystic adenomatoid malformation, and Potter's syndrome with associated hypoplastic lungs. ETT placement, patency, and chest-wall rigidity have been addressed previously (see Section 1).

Unilateral or bilateral tension pneumothoraces should also be considered whenever there is a poor response to resuscitation. Poor breath sounds over one side (and sometimes both sides), increased anterior-posterior diameter of the chest, or the presence

of subcutaneous emphysema should make one seriously consider an underlying pneumothorax. Transillumination, chest X-ray or thoracentesis may be diagnostic. Taking an x-ray and obtaining results takes too long in a delivery room setting, especially if the child is in extremis. Unilateral or bilateral pneumothoraces are common sequelae of attempting to ventilate hypoplastic lungs.

"This infant had Potter's syndrome, and an oligohydramnios sequence was established at autopsy. The diagnosis was strongly suspected clinically based on a history of a small amount of amniotic fluid, amnion nodosum – debris, such as squames and hair intermixed with sebum, normally suspended in amniotic fluid, form nodules on the fetal side of the placental surface, (4) (see Figure 1 below), a Potter's facies and other associated deformations, and a poor response to appropriate resuscitation."

This infant had Potter's syndrome, and an oligohydramnios sequence was established at autopsy. The diagnosis was strongly suspected clinically based on a history of a small amount of amniotic fluid, *amnion nodosum* – debris, such as squames and hair intermixed with sebum, normally suspended in amniotic fluid, form nodules on the fetal side of the placental surface, (4) (see Figure 1 below), a Potter's facies and other associated deformations, and a poor response to appropriate resuscitation. Chest x-ray showed a good position of the ETT and a left tension pneumothorax. Chest tube placement did not result in improvement. An ultrasound of the abdomen demonstrated an absence of the kidneys bilaterally.

Figure 1. *Amnion nodosum in the placenta of a newborn with renal agenesis. Note the uniform presence of fine granules, mostly sparing the vessel surfaces and not present on the cord. (From Benirschke K, Kaufman P: Placental Membranes in Pathology of the Human Placenta, 2nd ed. New York, Springer-Verlag, 1990, p160. Reproduced with permission.)*

At four hours of age, the infant died in her parents' arms, following a discussion with the parents and withdrawal of life support.

Normal umbilical cord blood gas values likely reflect the absence of asphyxia at the time of delivery. The very abnormal arterial blood gas obtained from the infant at 30 minutes of age reflects the inability of hypoplastic lungs in this infant to support extrauterine life.

Whenever an infant responds poorly to resuscitation, one must also consider severe anemia, hypovolemia, and other issues (see Section 6 on Cord Occlusion and Case 22 on acute fetal hemorrhage). However, with severe anemia or severe hypovolemia, one would not expect normal or near-normal umbilical cord blood gas values.

Key Points

- Low Apgar scores have many causes other than current fetal asphyxia (see differential diagnosis, Table 3, Section 1).
- In the absence of other complications, a newborn with renal agenesis would be expected to have normal or near-normal umbilical cord blood gas results.
- Chronic, severe oligohydramnios may be suspected in the delivery room by obtaining a good history, carefully examining the infant for findings suggestive of oligohydramnios sequence, and carefully examining the placenta for *amnion nodosum* on the chorionic plate.

References:

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