



## UMBILICAL CORD BLOOD GASES: THEIR IMPORTANCE

by Wesley Granger PhD, RRT

There has recently been a renewed interest in the clinical measurement of umbilical cord blood gas values, especially pH measurements. Questions involving pH measurements of cord blood have appeared on several Respiratory Care e-mail lists. I decided to attempt to research this topic and present my findings in this article. Most of the published studies have attempted to correlate the cord blood gas values with adverse outcomes in newborns including both full-term and pre-term births. This sampling at the time of birth is considered an important means of determining fetal acid-base and oxygenation status and assessing hemoglobin concentrations. This sampling is sometimes limited in value because of small sample sizes. The usual method used in these studies was to sample blood from a clamped segment of cord that was clamped immediately after birth of the infant and before placental delivery. Several obstetrical guidelines have also

**Recent studies indicate that umbilical artery blood should be sampled since this reflects the state of the infant**

been published that outline the protocols that should be used to determine the probability of adverse events based on cord blood gas values obtained by these methods.

I will begin by briefly reviewing the basic anatomy and physiology of the fetal circulation, reviewing the normal

values in cord segments from newborns, a discussion of the importance of these measurements, and finally conclusions.

### *Fetal Circulation Anatomy and Physiology*

The lungs are nonfunctional during intrauterine life and the liver does not receive much blood flow during this time. A large amount of blood is pumped by the fetal heart to the placenta for oxygenation and removal of waste products. The blood returning to the fetus through the umbilical vein mostly passes through the ductus venosus and therefore only a small amount goes to the liver. Most of the blood entering the right atrium from the inferior vena cava passes through the posterior aspect of the right atrium passing through the foramen ovale directly into the left atrium. This means that the majority of the well oxygenated blood from the placenta moves to the left side of the heart. Therefore most of the blood leaving the left ventricle is highly oxygenated and is delivered mainly to the head and upper limbs. What small

amount of deoxygenated blood enters the right atrium from the superior vena cava is directed through the tricuspid valve into the right ventricle. Blood from the right ventricle will travel through the pulmonary artery and then most of this blood will go through the ductus arteriosus into the aorta. Blood from the aorta enters into the two umbilical arteries to the placenta where oxygenation occurs.

The result of this fetal circulation arrangement is that blood sampled from the umbilical arteries will be deoxygenated blood and reflect the metabolic state of the fetus and blood sampled from the umbilical vein will be oxygenated blood from the placenta reflecting the functional aspects of placental gas exchange. The research studies I reviewed looked at blood gas results from the umbilical artery, umbilical vein or from both.

### *Normal Values*

A study in 2003 by Victory et al. looked at the umbilical artery pH and umbilical vein pH in a large group of newborns divided into preterm infants (PT group) and very preterm infants (VPT group). Their results showed Mean  $\pm$  SD pH values of  $7.26 \pm 0.07$  from the umbilical artery and  $7.33 \pm 0.06$  from the umbilical vein for the PT group. The results from the VPT group showed Mean  $\pm$  SD pH values of  $7.26 \pm 0.09$  from the umbilical artery and  $7.33 \pm 0.08$  from the umbilical vein. In 2005 Nodwell et al. looked at umbilical artery and vein blood gases in three groups of newborns, Term, Term Cesarean, and Preterm. The method used was to double clamp the cord immediately after birth and then within 1 to 2 minutes blood was sampled from the segment artery first and then the vein. They found no significant differences for umbilical artery blood gas values between the three groups and no significant differences for umbilical vein blood gas values between the three groups. Therefore, they combined the three groups into one group to report the results. Results showed the following values (Mean  $\pm$  SD) for the umbilical vein: pH =  $7.35 \pm 0.05$ , PO<sub>2</sub> =  $28.7 \pm 5.9$  mm Hg, PCO<sub>2</sub> =  $41.1 \pm 7.2$  mm Hg. The umbilical artery



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results: pH = 7.26 ± 0.06, PO<sub>2</sub> = 16.0 ± 4.6 mm Hg, PCO<sub>2</sub> = 55.4 ± 7.6 mm Hg.

A clinical guideline published by the UNC School of Medicine at Chapel Hill was published in 2005. This guideline uses a critical cutoff value for umbilical artery pH of 7.10. If the umbilical artery pH is less than 7.10 and the PCO<sub>2</sub> is less than or equal to 74 mm Hg the guideline defines the acid-base status as metabolic acidosis. If the PCO<sub>2</sub> is greater than 74 mm Hg then both a Respiratory and metabolic acidosis exists. In March 2005 the British Columbia Reproductive Care Program published Obstetric Guideline 6B on fetal monitoring. The guideline states that blood in a double clamped segment of the umbilical cord is stable for up to an hour at room temperature but once the sample is drawn into a syringe it must be analyzed within 30 to 60 and kept at room temperature. They report the following normal values (Mean ± SD) for umbilical artery blood from term infants: pH = 7.27 ± 0.069, PCO<sub>2</sub> = 50.3 ± 11.1 mm Hg, HCO<sub>3</sub> = 22.0 ± 3.6 mEq/L and for umbilical venous blood: pH = 7.34 ± 0.063, PCO<sub>2</sub> = 40.7 ± 7.9 mm Hg, HCO<sub>3</sub> = 21.4 ± 2.5 mEq/L.

### Clinical Outcomes

Although the previously mentioned guideline uses a critical cutoff value for umbilical artery pH of 7.10 more recent studies give a value of 7.20. A study in 2004 by Victory et al. evaluated the correlation between adverse outcomes and umbilical artery pH using logistic regression analysis with odds ratio calculations using a critical cutoff pH value of 7.20. This study found an

umbilical artery pH of 7.24 ± 0.07 in their population of 20,456 singleton, term, live born infants. Their analysis determined a significant inverse relationship between Apgar score < 7 and 5 minutes, NICU admission, and need for assisted mechanical ventilation and umbilical artery pH by logistic regression. Using a critical cutoff value of 7.20 they determined the odds ratio for each of these outcomes. The values for the odds ratio are given as OR with 95% confidence intervals in parentheses. For having an Apgar < 7 at 5 minutes if pH < 7.20 the odds ratio was 4.7 (3.4-6.5), for NICU admission the odds ratio was 2.3 (2.1-2.6) and for need of assisted mechanical ventilation the odds ratio was 6.4 (4.0-10.4).

### Conclusions

The most recent studies indicate that umbilical artery blood should be sampled since this reflects the state of the infant and not how well the placenta is functioning. However, if you suspect that placental malfunction might be a problem for an infant then both should be sampled. The accepted critical value is an umbilical artery pH less than 7.20. The studies reported above indicate that when the umbilical artery pH is less than 7.20 the odds of having an Apgar score < 7 at 5 minutes is 4.7 times higher, the odds of requiring NICU admission is 2.3 times higher, and the odds of requiring NICU admission is 2.3 times higher than if the pH > 7.20.

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