

# Erythroblastosis in birth asphyxia

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## ABSTRACT

The pH and erythroblast count in umbilical venous blood were measured in 27 term neonates with normal birth weights. In seven cases, infants were admitted to the neonatal intensive care unit because of birth asphyxia, and the findings in these cases were compared to the values of the 20 non-asphyxiated neonates that were delivered either vaginally ( $n = 10$ ) or by elective Cesarean section ( $n = 10$ ). The umbilical venous blood pH in the asphyxiated group was significantly lower than that in the control group of infants that were delivered by Cesarean section, but not significantly different from the controls that were delivered vaginally. In contrast, the erythroblast count in the asphyxiated group was significantly higher than that in the controls, irrespective of the mode of delivery. These findings suggest that cord blood erythroblast count at delivery may provide a better measure of fetal tissue hypoxia than umbilical venous pH.

## INTRODUCTION

Blood pH in samples obtained from the umbilical cord at delivery is a widely accepted measure of fetal oxygenation. However, pH may be susceptible to acute changes during labor and delivery, offering a possible explanation for the poor association between low blood pH and neonatal morbidity or long-term handicap<sup>1,2</sup>.

A better measure of prolonged tissue hypoxia, and subsequent morbidity, may be provided by the degree of erythroblastosis. The erythroblast count in umbilical cord blood, obtained either antenatally or at delivery, is elevated in at least three different models of impaired fetal tissue oxygenation:

- (1) Hypoxemic hypoxia in growth retardation due to reduced placental perfusion;
- (2) Anemic hypoxia due to red cell isoimmunization; and
- (3) Metabolic acidosis in maternal diabetes mellitus<sup>3–6</sup>.

To test the hypothesis that erythroblastosis is better than acidemia in predicting neonatal morbidity, the erythroblast count and pH in cord blood at delivery from normal and birth-asphyxiated neonates were compared.

## PATIENTS AND METHODS

In a retrospective examination of the records of infants admitted to the neonatal intensive care unit of our hospital during a 3-month period, because of the diagnosis of birth asphyxia, seven neonates were identified that fulfilled the following criteria:

- (1) Delivery at term;
- (2) Birth weight appropriate for gestational age;
- (3) No congenital abnormality or evidence of infection; and
- (4) Measurement of both cord blood pH and erythroblast count.

Subsequently, in a prospective study, cord blood pH and erythroblast count were measured in neonates with birth weight appropriate for gestational age from 20 normal pregnancies delivered at term. There were ten vaginal deliveries and ten elective Cesarean sections, for either breech presentation ( $n = 3$ ) or previous Cesarean section ( $n = 7$ ). At delivery, the umbilical cord was double clamped and the umbilical venous blood collected into heparinized syringes for measurement of pH (Radiometer ABL 330, Copenhagen, Denmark). Cord blood was also collected into isotonic edetic acid solution and the total nucleated cell count was determined with a Coulter Stacker Automated Cytometer (Coulter Electronics, Luton, England). Blood films were stained by the May–Gruwald–Giemsa method and the number of erythroblasts per 100 white cells was counted. The absolute erythroblast count was calculated and expressed as number of erythroblasts  $\times 10^9/l$ .

Mann–Whitney tests were used to determine the significance of any differences between the groups.

## RESULTS

The mothers of the asphyxiated neonates were healthy and had no antenatal complications. In all cases the onset of labor was spontaneous but three neonates were delivered by emergency Cesarean section because of abnormal intrapartum fetal heart rate patterns. All neonates required either head-box oxygen or ventilation,

and in one case phenobarbitone was given for neonatal seizures. They all made a full recovery and were discharged from the neonatal unit over a period of 2–23 (median = 6) days.

Their gestational age at delivery and birth weight were not significantly different from those in the non-asphyxiated group (Table 1). However, the Apgar scores of the asphyxiated neonates at both 1 min and 5 min were significantly lower than the corresponding values for the normal neonates that were delivered either vaginally or by elective Cesarean section (Table 2).

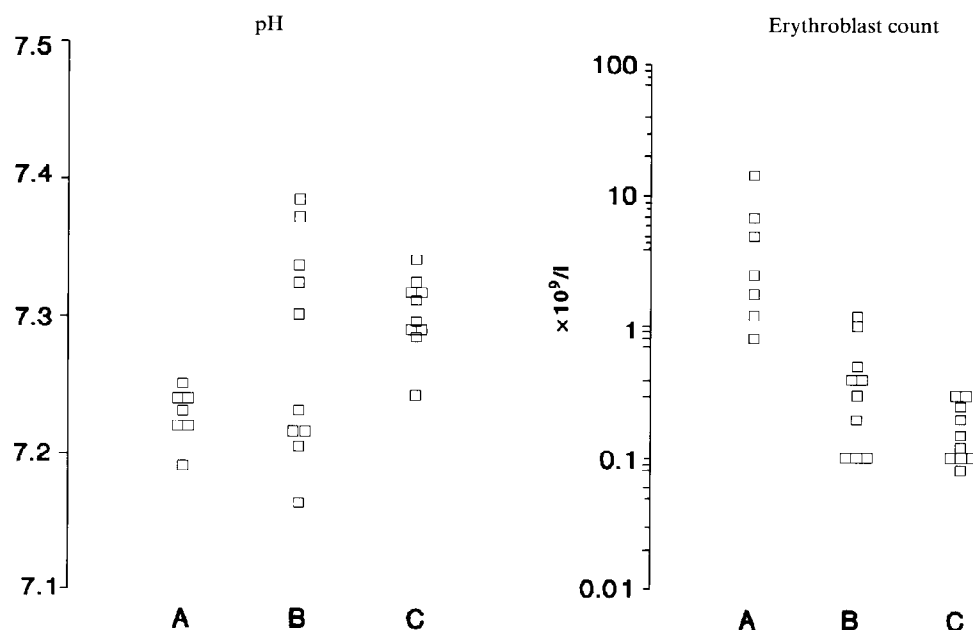
**Table 1** Gestational age at delivery and birth weight in the asphyxiated and non-asphyxiated neonates

	Asphyxiated neonates		Non-asphyxiated neonates		z
	Median	Range	Median	Range	
Gestational age (weeks)	40	39–41	40	37–42	0.94
Birth weight (g)	3280	2950–3560	3395	2900–4620	1.02

**Table 2** Apgar score, umbilical venous blood pH and erythroblast count in the asphyxiated neonates and the non-asphyxiated neonates delivered either vaginally or by elective Cesarean section

	Asphyxiated neonates		Non-asphyxiated neonates									
	Median	Range	Vaginal delivery				Cesarean section					
			Median	Range	z	p	Median	Range	z	p		
Apgar score												
1 min	4	1–9	9	8–10	2.38	< 0.05	9	8–9	2.33	< 0.05		
5 min	7	4–9	10	9–10	3.16	< 0.01	10	8–10	2.88	< 0.01		
pH	7.23	7.190–7.250	7.27	7.162–7.385	0.64	NS	7.30	7.242–7.341	3.32	< 0.001		
Erythroblast count ( $\times 10^9/l$ )	2.50	0.8–14.4	0.35	0.1–1.2	3.18	< 0.01	0.15	0.1–0.3	3.47	< 0.001		

NS, non-significant



**Figure 1** Individual values of cord blood pH (left) and erythroblast count (right) for the asphyxiated (A) and for the normal neonates that were delivered either vaginally (B) or by Cesarean section (C)

The umbilical venous blood pH in the asphyxiated group was significantly lower than the pH of the normal neonates that were delivered by elective Cesarean section but was not significantly different from the pH of the normal neonates that were delivered vaginally (Figure 1 and Table 2).

The erythroblast count in the asphyxiated group was significantly higher than in the normal neonates that were delivered either vaginally or by elective Cesarean section (Figure 1 and Table 2). The highest erythroblast count was found in the neonate with seizures; the umbilical venous blood pH was 7.22. In the normal group, the erythroblast count was not significantly different between those that were delivered vaginally and those delivered by elective Cesarean section ( $z = 1.81$ ).

## DISCUSSION

In neonates with birth asphyxia, the umbilical cord blood erythroblast count is increased. These data suggest that erythroblastosis is the result of inadequate antepartum and/or intrapartum fetal oxygenation. The most likely

cause of the erythroblastosis is tissue hypoxia resulting in secondary recruitment of extramedullary erythropoiesis. Alternatively, erythroblastosis may be due to severe medullary hypoxia, and breakdown of the mechanisms that normally prevent release of nucleated erythroid precursors into the circulation.

In the non-asphyxiated neonates, there was a tendency for higher erythroblast counts in those delivered vaginally than by elective Cesarean section, suggesting that the hypoxia of 'normal' labor may be sufficient to cause a minor degree of erythroblastosis.

The lack of a significant difference between the cord blood pH of asphyxiated and normal neonates delivered vaginally supports the findings of previous studies that cord blood pH at delivery is a poor predictor of neonatal morbidity<sup>7,8</sup>. Furthermore, all but one of the asphyxiated group had a blood pH of more than 7.20 and were therefore not acidemic.

This study has demonstrated that the umbilical cord blood erythroblast count may be a good predictor of 'birth asphyxia'. However, unlike pH, measurement of the erythroblast count is time consuming, approximately 40 min, and requires manual preparation, staining of blood films and counting by trained operators. Nevertheless, if the results of this preliminary study are confirmed in a larger prospective study, measurement of erythroblast count in cord blood may replace pH as the index

of fetal oxygenation, both at delivery and for the antenatal diagnosis of fetal tissue hypoxia at cordocentesis.

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