

# A Study on Correlation of Umbilical Cord Arterial Blood pH with Perinatal Asphyxia & Early Neonatal Outcome

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## Abstract

**Background:** Perinatal asphyxia is one of the major causes of neonatal morbidity & mortality. Asphyxia can damage almost every organ of neonate. Our purpose was to determine the correlation of cord blood pH with birth asphyxia & early neonatal outcome. **Subjects and Methods:** A prospective study was conducted over a period of one year at STH Haldwani. We enrolled 108 term neonates with signs of fetal distress, thick MSL, non-reassuring NST & there were subjected for estimation of umbilical cord blood pH, APGAR score, outcome looked were resuscitation needed, NICU admission, delay in feed & encephalopathy (sarnat & sarnat stage). **Results:** In our study, cord blood pH had significant correlation with perinatal asphyxia ( $R=-0.926$ ). Area under ROC curved showed that mean pH  $<7.1$  (ROC=0.998) is very significant in predicting the adverse outcome. **Conclusion:** Cord blood pH is very sensitive and specific & has good correlation in predicting the birth asphyxia & adverse neonatal outcome. Measurement of cord blood pH is recommended in all the neonates with signs of fetal distress.

**Keywords:** pH, non-stress test, Apgar score, perinatal asphyxia

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## Introduction

Perinatal asphyxia is a most common preventable cause of neurological injury in new borns & a leading factor which significantly increases the neonatal morbidity and mortality. It is characterized by an impairment of exchange of the respiratory gases (oxygen and carbon dioxide) resulting in hypoxemia and hypercapnia, accompanied by metabolic acidosis. In response to persistent hypoxia during perinatal period and anaerobic metabolism, baby will develop acidosis. It is a multi-organ disorder affecting virtually every organ system in the body including brain, heart, lungs, kidneys and intestine. The prime concern is CNS dysfunction (Hypoxic ischaemic encephalopathy) because it is not only associated with high risk of mortality but also carries significant risk of serious long-term neuromotor sequelae. Despite the recent advances and protocols in perinatal care, Perinatal asphyxia is a leading cause of infant morbidity and mortality worldwide. Although the infant mortality due to infectious diseases have been significantly reduced but perinatal asphyxia is still one of challenging problem especially in rural population. As per latest estimates, perinatal asphyxia accounts for 9.4% (i.e.,

0.72 million) of total under 5 child mortality worldwide. Along with prematurity and systemic infections, Perinatal asphyxia is one of three most common causes of neonatal deaths.<sup>[1,2]</sup> It is also an important cause of stillbirths and according to the National neonatal perinatal database (NNPD; 2002-2003), perinatal asphyxia is the commonest cause of stillbirths, accounting for 45.1% of all such cases.<sup>[3]</sup> World Health Organization defined birth asphyxia as “the failure to initiate and sustain breathing at birth”. A precise definition of birth asphyxia is given by the American College of Obstetrician and gynaecologists (ACOG), American Academy of Paediatrics (AAP) includes existence of 3 factors: Metabolic or mixed academia (pH<7) which is determined by umbilical cord arterial blood samples; APGAR score of <3 for longer than 5 min; neurological manifestations; and multisystem organ dysfunction. NNPD network define the perinatal asphyxia as; Moderate Perinatal asphyxia: slow/ gasping breathing or an APGAR score of 4 to 6 at 1 minute & Severe Perinatal asphyxia: no breathing or an APGAR score 0-3 at 1 minute.<sup>[4-6]</sup>

Although perinatal asphyxia is commonly encountered diagnosis at birth, there is no common consensus regarding its definition & various criteria has been given to label it perinatal asphyxia by WHO, NNPD, AAP & ACOG. our study is attempted to look for any association of the umbilical cord pH value with perinatal asphyxia & early neonatal outcome in neonates with signs of foetal distress. Early neonatal outcomes were measured by various parameters such as, need for resuscitation, NICU admission, neurological examination (tone, seizures & HIE staging), delay in starting & attaining full feed & final outcome (death/ discharge).

## Subjects and Methods

This is a prospective study was carried out at susheela Tiwari hospital, Haldwani, affiliated to kumaun University Uttarakhand. One hundred eight singleton pregnant women of more than 37 weeks of gestation were included in the study from January 2018 to December 2018. Study was approved by the ethical committee and informed consents were taken from the parents. 108 neonates were studied who met the following

### Inclusion Criteria

1. Singleton , live born neonates of gestational age > 37 weeks, AGA
2. Suspected perinatal asphyxia
  - (a) Signs of intrapartum fetal hypoxia, as indicated by non-reassuring Non- stress test on continuous electronic fetal monitoring.
  - (b) Thick meconium stained liquor
  - (c) Apgar score of <7 at 1 min of life
  - (d) Need for resuscitation for > 1 minute

### Exclusion Criteria

- (a) Preterm and low birth babies
- (b) Multifetal gestation
- (c) IUGR babies
- (d) Babies with intrauterine and perinatal infections
- (e) Gross congenital malformations
- (f) History of maternal intrapartum fever
- (g) Maternal drug addiction,
- (h) Anti-epileptics use by mothers

Immediately after birth of asphyxiated new born, 1 ml of blood was collected in heparinised syringe from doubly clamped segment of umbilical cord for ABG and another 2 ml blood collected in EDTA vial for routine investigations. All these new-borns were shifted to NICU for further monitoring, screening and staging of HIE as per sarnat and sarnat

staging. The admitted new-borns were observed for immediate outcome during 24 hours and classified as neurologically normal or abnormal on basis of presence of signs and symptoms of HIE. All the cases were followed up till discharge or death for final outcome. A detailed maternal history, APGAR score, examination & investigation of enrolled baby was done. Outcome variables:- 1) Need for resuscitation 2) Need for NICU/Neonatal ward admission 3) Delay in attaining full feeds 4) Neurological examination 5) Death/ discharge.

Analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0 and P values less than 0.05 were considered statistically significant.

## Results

Among 108 neonates, 61 (56.48%) were male and 47 (43.52%) were female, 95 (87.90%) were term, 9 (8.33%) were post-dated & 4 (3.70%) were post term. 101 (93.52%) babies were delivered by vertex presentation and 7 (6.48%) by breech. 84 (77.78%) babies had birth weight between 2.5-3 Kg, 14.81% between 3-3.5 kg & 7.41% babies more than 3.5Kg. 48(44.44%) neonates were delivered normally, 60 (55.56%) were delivered by caesarean section. 15 (13.89%) had Reassuring NST and 93 (86.11%) had Non-Reassuring NST suggestive of fetal distress. 26 (24.07%) neonates had Thick MSAF and in 82 (75.93%) the amniotic fluid was clear. Mean APGAR score at 1min was 3.27 and at 5min 6.27. [Table 1]

Neonatal outcome was studied by various parameters like need for resuscitation, NICU admission, neurological abnormalities, delay in feed, and final outcome i.e. death/discharge. These babies were not followed for long term neurodevelopmental sequelae. Out of 108 studied neonates, 78 (72.2%) needed resuscitation whereas 30 (27.78%) didn't need any form of resuscitation, 77 (71.30%) babies were admitted in NICU for care & management as per protocols, whereas 31 (28.70%) neonates were shifted to mother side & followed up till discharge. In neurological examination, 70 (64.81%) neonates had normal tone, 25 (23.15%) had flaccid tone & 13 (12.04%) showed increased tone, 72 (66.67%) had no seizures while 36 (33.33%) had seizures as an abnormal neurological examination finding. 52 (48.15%) were neurologically normal without encephalopathy, 20 (18.52%) were in HIE stage 1, 11 (10.19%) were in stage 2 & 25 (23.15%) were in stage 3 of hypoxic ischemic encephalopathy according to sarnat & sarnat staging. Among 108 neonates, feed was started in 87 neonates, out of them 28 (32.56%) had delay in attaining full feed whereas 59 (67.44%) had attained feed timely. 21 neonates were too sick for feed to be started & they ultimately died during hospital stay and 87 (80.56%) babies were discharged from hospital. [Table 2]

Correlation coefficient and P value was calculated for cord blood pH and ischemic brain injury among the newborns with hypoxic ischemic encephalopathy & it was observed that it is statistically significant (p value<0.001) & significant negative correlation with severity of birth asphyxia. [Table 3 & Figure 1]. Table 4 shows the babies with and without encephalopathy and their corresponding pH values.

Table 5-10 showing, neonatal morbidities in the form of need for resuscitation, NICU admission, seizure, stages of encephalopathy, delay in feed & final outcome i.e. death/discharge with their mean pH values. Figure 2, shows Umbilical cord pH value with cut off <7.1 has area under ROC curve (0.998), standard error=0.00149, sensitivity=96.43%, specificity=98.08%, positive predictive value=98.2 & negative predictive value=96.2.

**Table 1: Birth weight**

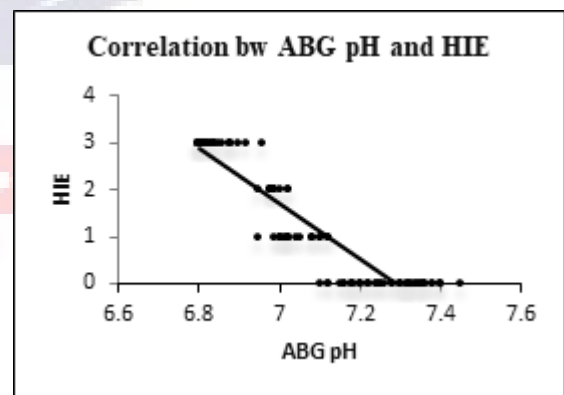
Clinical variable Birth weight	Case =108
2.5-3.0 kg	84(77.78%)
3.1-3.5kg	16(14.81%)
>3.5kg	8(7.41%)
Sex	
Male	61(56.48%)
Female	47(43.52%)
Gestation	
Term	95(87.96%)
Post term and post dated	13(12.04%)
Mode of delivery	
NVD	48(44.44%)
LSCS	60(55.56%)
PRESENTATION	
VERTEX	101(93.52%)
BREECH	7(6.48%)
AMNIOTIC FLUID	
MECONIUM STAINED	26(24.07%)
CLEAR	82(75.93%)
APGAR	
MEAN APGAR AT 1 MIN	3.27
ME APGAR AT 5 MIN	6.27
NON STRESS TEST	
NON REASSURING	93(86.11%)
REASURING	15(13.89%)

**Table 2: Neonatal Outcome**

Resuscitation	Yes	72.2%
	No	27.78%
NICU admission	Yes	71.30%
	No	28.70%
Delay in feed	Yes	32.36%
	No	67.44%
Seizures	Yes	33.33%
	No	66.67%
Abnormal tone	Yes	35.19%
	No	64.81%
HIE	No HIE	48.15%
	STAGE 1	18.52%
	STAGE 2	10.19%
Final outcome	STAGE 3	23.15%
	DEATH	19.44%
	DISCHARGE	80.56%

**Table 3: Correlation Coefficient of Cord Blood PH to Predict the Severity of Birth Asphyxia**

Parameter	P value	Correlation coefficient
Cord Blood Ph	<0.001	-0.926



**Figure 1: ?**

**Table 4: HIE**

	1) Not in HIE	2) HIE
ABG pH		
Sample size	52	56
Mean ± Stdev	7.28 ± 0.08	6.94 ± 0.1
Median	7.3	6.98
Min-Max	7.1-7.45	6.8-7.12
Inter quartile Range	7.200 - 7.340	6.840 - 7.020

**Table 5:** Resuscitation

Variables	No	Yes	P value
ABG pH	-	-	<.0001
Sample size	30	78	
Mean ± Stdev	7.32 ± 0.07	7.02 ± 0.16	
Median	7.32	7	
Min-Max	7.1-7.45	6.8-7.4	
Inter quartile Range	7.300 - 7.360	6.880 - 7.160	

**Table 6:** NICU Admission

	No	Yes	P value
ABG pH	-	-	<.0001
Sample size	31	77	
Mean ± Stdev	7.31 ± 0.08	7.02 ± 0.16	
Median	7.32	7	
Min-Max	7.1-7.45	6.8-7.4	
Inter quartile Range	7.300 - 7.360	6.880 - 7.160	

**Table 7:** Seizure

	Negative	Positive	P value
ABG pH	-	-	<.0001
Sample size	72	36	
Mean ± Stdev	7.21 ± 0.13	6.89 ± 0.08	
Median	7.22	6.87	
Min-Max	6.95-7.45	6.8-7.02	
Inter quartile Range	7.100 - 7.320	6.820 - 6.980	

**Table 8:** Delay in feed

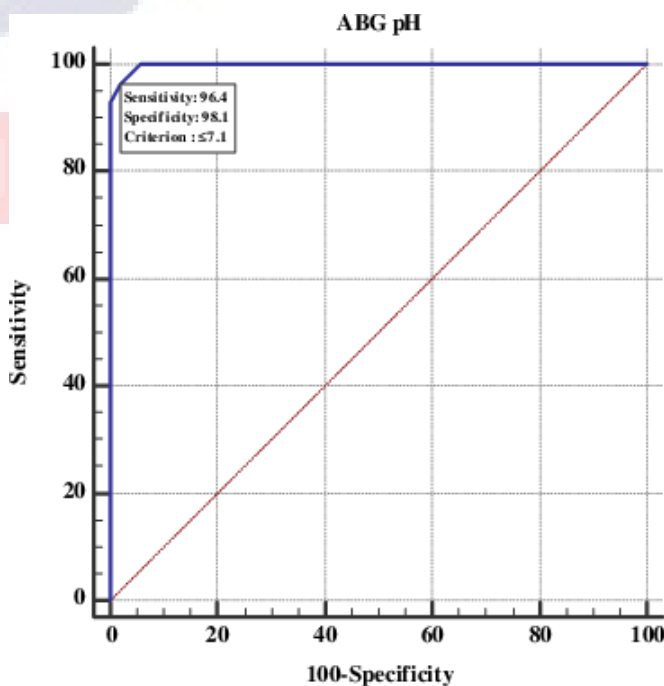
	No	Yes	P value
ABG pH	-	-	<.0001
Sample size	58	28	
Mean ± Stdev	7.25 ± 0.11	7 ± 0.09	
Median	7.28	7	
Min-Max	7-7.45	6.8-7.22	
Inter quartile Range	7.180 - 7.330	6.980 - 7.020	

**Table 9:** HIE Stage and Mean Ph Values

	Case(n)	Mean pH
NO HIE	52	7.28±0.08
HIE STAGE 1	20	7.04±0.04
HIE STAGE 2	11	6.99±0.01
HIE STAGE 3	25	6.84±0.04

**Table 10:** Final Outcome

	Death	Discharge	P value
ABG pH	-	-	
Sample size	21	87	
Mean ± Stdev	6.84 ± 0.04	7.17 ± 0.16	
Median	6.83	7.18	
Min-Max	6.8-6.96	6.8-7.45	
Inter quartile Range	6.810 - 6.880	7.020 - 7.320	



**Figure 2:** ROC curve for cord blood pH and birth asphyxia

## Discussion

In our study, 56(41.85%) neonates out of 108 samples showed neurological morbidity in the form of hypoxic ischemic insult with 20(18.52) in HIE stage 1, 11(10.2%) in HIE 2 & 25(23.15%) cases in HIE stage 3, previous studies done by N.N. Finner and C.M. Robertson et al in their study of 33 cases, 35% were in stage-1, 50% were in stage II and 15% were in stage III and in the study by Sarnat and Sarnat et al among 21 cases, 7 (33) cases were in Stage 1, 9 cases (43%) were in stage-II and one (5%) case were in stage-III.<sup>[7,8]</sup>

As there is no common consensus to define the perinatal asphyxia, we used AAP & recent NNF criteria, a pH less than 7 was considered as significant acidemia. In our study 35.48% cases had umbilical pH <7 and 64.52% had pH >7, similar results were observed in study by Prasanna R. et al and Goldaber and colleagues.<sup>[8-10]</sup> In our study, Incidence of seizures was higher at 32%, when compared with studies by other workers, Goodwin et al, Andres et al & Vanderberg et al.<sup>[11-13]</sup> Lower incidence was seen in study done by Goodwin et al (1%), Andres (5.2%) & vanderberg (5.5%) and a higher incidence (10%) in study done by Sehdev and co-workers which correlates with our study.<sup>[14]</sup> We observed that as the pH value decreases, the incidence of convulsions increases & this finding is supported by other studies Goodwin et al, Andres et al, Perlman & Risser et al.<sup>[11,12,15]</sup> In present study, babies with pH >7 had only 8% seizures while at pH between 6.9 to 7.0, the incidence of convulsions were 32% which significantly increased to 60% with pH <6.9. similar results were observed in study by Goodwin et al, the incidence of seizures was 9% in pH= 6.9-6.99 & 80% in pH 6.61-6.70. In our study, 78 neonates out of 108 cases needed some form of resuscitation with mean pH  $7.02 \pm 0.16$  when compared to babies who didn't need resuscitation (n=30), mean pH was  $7.32 \pm 0.07$ , similar results had been observed in study by Mousa Ahmadpo.<sup>[11,16]</sup>

In present study, 71.3% babies needed NICU admission with mean pH  $7.02 \pm 0.16$ , when compared with other neonates who were shifted to mother side without any need of NICU admission with mean pH  $7.31 \pm 0.08$  which was statistically significant ( $p < 0.0001$ ). Our results are supported by Ahmadpour Mousa et al who studied the factors affecting the neonatal outcomes.<sup>[16]</sup> 16 babies with pH less than 7.2 required NICU admission in compared to 3 babies in the other group with pH more than 7.2 & the difference was statistically significant ( $p < 0.05$ ). Victory et al observed that the risk for NICU admission increased with worsening of acidemia at birth in term neonates.<sup>[17]</sup> Another study by Rogers et al, it was concluded that neonates with pH value >7.02, only 50% required resuscitation and 36.36% of cases needed NICU admission, while 100% babies required resuscitation and NICU admission at pH below 7.02, these results were also

observed in our study.<sup>[18]</sup> In this study there were 87 neonates in whom feed was started, 28 had delay in attaining full feeds with mean pH  $7 \pm 0.09$  & rest 59 neonates (pH= $7.25 \pm 0.11$ ) had attained full feed timely. 21 neonates were too sick for feed to be started & they died ultimately during the hospital stay. P value of 0.0001 was obtained after applying Fischer exact test, which is statistically significant. Study by Mousa Ahmedpour they found similar results of pH with delay in starting feeds.<sup>[16]</sup>

In present study, out of 108 cases 56 babies were neurologically abnormal (HIE Stage 1, 2 & 3) with mean pH value  $6.94 \pm 0.1$  (median=6.98) when compared with neonates without any neurological sequelae (n=52), mean pH was  $7.28 \pm 0.08$  (median=7.3) ( $p < 0.001$ ). A meta-analysis by Gemma L Malin found that low umbilical cord arterial pH was significantly associated with poor neonatal outcomes.<sup>[19]</sup> Encephalopathy (HIE 1, 2 & 3) was closely linked with odds ratio 16.9, 95% confident interval 9.7 to 29.5 in neonates with low arterial cord pH. Study by Yeh P1 et al found that seizure within 24 hours of life was more among neonates with pH <7.1.<sup>[20]</sup> Study done by Goldaber et al and Goodwin et al who worked on whether fetal acidemia indicated by low umbilical cord blood pH was associated with an adverse neonatal outcome.<sup>[10,11]</sup>

In our study, total 21(19.44%) babies died & among them 19 neonates belonged to pH range 6.80-6.89, two babies had pH value between 6.90-6.99. All the deaths were observed at pH below 7.0. Similar results were seen in study by Vanderberg et al,<sup>[13]</sup> mortality was 23% at pH below 7.0, whereas in other studies much less deaths were observed at pH <7, Goldaber et al,<sup>[10]</sup> 5%, Andres et al,<sup>[12]</sup> 4.5%, Goodwins et al,<sup>[11]</sup> 2.3% & Nagel et al,<sup>[21]</sup> 10%. Mortality at pH >7 was seen in 2 studies only, Goldaber et al,<sup>[10]</sup> 1.6% & Vanderberg et al,<sup>[13]</sup> 1.1%. Similarly, we didn't find any death at pH above 7.0.

## Conclusion

It is necessary to identify the babies, who will be at high risk for intrapartum hypoxia & poor neonatal outcome, early death as a complication of asphyxia. We attempted to find the correlation of cord blood pH with birth asphyxia & its effect on early neonatal outcome. A lower mean pH was observed in neonates who showed signs of fetal distress, need for resuscitation, need for resuscitation & had poor neurological outcome, when compared to babies with a pH >7.1. As umbilical cord pH is significantly associated with predicting the poor neonatal outcome such as need for resuscitation, NICU admission, seizures, encephalopathy & early neonatal mortality, this study shows that pathological acidemia is observed at pH <7.10 rather than <7 as suggested by AAP & NNF and <7.20 as defined by ACOG.

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