



## Original Research Article

# STUDY ON UMBILICAL ARTERY BLOOD GAS PARAMETERS AND ITS ASSOCIATION WITH PERINATAL OUTCOME AND WITH APGAR SCORE

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### ABSTRACT

**Background:** The APGAR score has been found to have a misdiagnosis rate ranging from 50% to 80%, indicating a high level of sensitivity but low level of specificity. To enhance the precision and accuracy of diagnosing newborn asphyxia, it is advisable to augment the standard complete asphyxia diagnostic by including neonatal umbilical cord blood gas analysis. The aim of study was to analyze umbilical artery blood gas parameters and its association with perinatal outcome and with APGAR score.

**Materials and Methods:** The study population consisted of ninety newborns who were delivered using various techniques of delivery at Bharatratna Dr. Babasaheb Ambedkar Memorial Hospital, Byculla, Mumbai. A blood sample from the umbilical cord arterial region was obtained using a pre-heparinized syringe within 30 minutes after birth. The sample was then transferred using ice packs and examined within a time frame of 1 hour. The blood gas parameters were recorded.

**Results:** Ninety eligible participants participated in the study. In  $BD \geq 16$  group, 52% new-borns had birth weight between 1.5-2.5kg. 20% patients in  $pH \leq 7$  group and 24% in  $BD \geq 16$  group patient required intubation. 53.3% patients with  $pH \leq 7$  and 72% patients with  $BD \geq 16$  needed oxygen support. 51.7% patients with  $pH \leq 7$  and 70.8% patients with  $BD \geq 16$  required NICU stay. Complications were more associated in  $pH \leq 7$  and  $BD \geq 16$  groups with predominant respiratory complications.

**Conclusion:** Neonatal complications and need for NICU stay observed within 7 days of life, were more prevalent in newborns with  $pH \leq 7$  and  $BD \geq 16$  in umbilical cord arterial blood gas analysis showing highly significant correlation.

**Keywords:** Umbilical cord, APGAR score, neonatal outcomes, blood gas parameters.

## INTRODUCTION

Fetal and neonatal acidemia are linked to many negative consequences in newborns.<sup>[1]</sup> Fetal acidity, as assessed by umbilical cord pH at delivery, is a reliable predictor of perinatal asphyxia, which is a significant contributor to neonatal and childhood mortality and morbidity. These complications include hypoxic ischemic encephalopathy, seizures, intraventricular hemorrhage, cerebral palsy, and delayed development.<sup>[2]</sup> The objective of fetal surveillance is to detect fetuses that are susceptible

to neonatal and long-term harm caused by asphyxia, with the goal of preventing illness and death. According to the guidelines set forth by the Royal College of Obstetricians and Gynecologists, it is recommended that a UCBGA should be performed in all cesarean or operative vaginal deliveries executed due to fetal compromise.<sup>[3]</sup> According to the American College of Obstetricians and Gynecologists, it is recommended to conduct a UCBGA follow-up after any delivery if there is suspicion of a fetal metabolic disorder.<sup>[4]</sup>

The utilization of umbilical cord blood acid base analysis has gained prominence in recent years as a means of scientifically evaluating newborns. This is due to the fact that other predictors of outcome, such as the APGAR score, rely on subjective criteria and have limited correlation with neonatal outcomes.<sup>[5]</sup> The APGAR score has been found to have a misdiagnosis rate ranging from 50% to 80%, indicating a high level of sensitivity but low level of specificity.<sup>[6]</sup> Additionally, the device is susceptible to many external influences, rendering it unsuitable for newborns undergoing endotracheal intubation. Given that the Apgar score typically does not accurately indicate the extent of acidity after delivery, its usefulness in evaluating asphyxia should be called into doubt.

According to existing research, it is suggested that enhancing the specificity and sensitivity of newborn asphyxia diagnosis can be achieved by incorporating neonatal umbilical cord blood gas measurement into the standard comprehensive diagnostic process.<sup>[7]</sup> Enhancing the diagnostic rate of neonatal asphyxia in patients experiencing fetal distress after birth can lead to a decrease in risk, an improvement in specificity, and the ability to differentiate the underlying cause of neonatal depression. This is especially crucial for effectively treating and predicting the prognosis of neonatal asphyxia resulting from fetal distress. The purpose of this study was to examine the blood gas parameters of the umbilical artery and their correlation with perinatal outcome and APGAR score.

## MATERIALS AND METHODS

The current study was cross-sectional in design and was carried out at Bharatratna Dr. Babasaheb Ambedkar Memorial Hospital, Byculla in Mumbai city. The study spanned a period of eleven and a half years, (from December 2020 to May 2022). The inclusion criteria for this study were all neonates delivered in this hospital, regardless of the mode of delivery attended by the principal investigator. The Ninety new-borns delivered by all modes of delivery attended by me in this hospital formed the study population. This study excluded cases involving life-threatening congenital abnormalities and stillbirths. Sample size calculation was performed with G\*Power software 3.1.9.2 version. Two-sided significance level (1-alpha) was fixed at 95% and Power (1-beta, % chance of detecting) was set as 90%. Using correlation test, Bivariate normal model at correlation value 0.34, minimum sample size came out as 86 study subjects.<sup>8</sup> Making a round

figure, 90 study subjects were taken up for this study.

### Umbilical arterial blood gas sampling

Following the birth of the infant, the obstetrics team proceeded to apply two clamps to the umbilical cord and subsequently severed the cord between these two clamps. The third clamp is positioned on the placental portion of the umbilical cord, with a minimum length of 10-12 cm, while the placenta remains in place. Within 30 minutes of birth, a 1cc sample was obtained from the umbilical artery using a pre-heparinized 2cc syringe and a 24-gauge needle that had been flushed with a 1/1000 heparin solution. The syringe was named. The specimen was stored in a vacuum and transferred for examination in ice packs within 1 hour of being collected. The Abbott i-stat handheld blood analyzer was used to test the blood gas parameters in the medical ICU. For purpose of study, severe acidosis defined as umbilical arterial blood gas samples with pH  $\leq 7$  and base deficit  $\geq 16$  mmol/lit <sup>76</sup> and this was considered as cut off point for two groups.

Infants were monitored for the initial 7 days of their lives to assess their prognosis. The comparison of these groups was conducted based on intubation required, oxygen support need, and NICU stay requirement.

The data that was gathered was inputted into the Microsoft Excel spreadsheet, suitably coded, and subsequently reviewed for potential inaccuracies. This study employed IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp. Armonk, NY, USA) for the purpose of analysis. During the process of data cleaning, additional variables were generated in order to enhance the link between variables. Percentages (%) were used to portray categorical data, whereas mean and standard deviation were employed to provide quantitative data. The tests were conducted with a significance level of 5%. Therefore, a relationship was considered significant if the p value was below 0.05.

## RESULTS

In the current study, a total of 90 eligible subjects were included in the study. In terms of gender, there were 50 male children and the rest children were female. Among the BD $\geq 16$  group, 52% of newborns had a birth weight ranging from 1.5 to 2.5 kg.

In this study, 20% patients in pH $\leq 7$  group and 24% in BD $\geq 16$  group patient required intubation. A significant association was found between newborns who required intubation with pH (p value=0.002) and BD (p value =0.0003). [Table 1]

**Table 1: Correlation of intubation with pH and base deficit**

Intubation	pH		BD	
	$\leq 7$	$> 7$	$< 16$	$\geq 16$
	No. of Patients	No. of Patients	No. of Patients	No. of Patients
Present	6(20%)	0(0%)	0(0%)	6(24%)
Absent	24(80%)	60(100%)	65(100%)	19(76%)
Total	30(100%)	60(100%)	65(100%)	25(100%)
p value	0.002		0.0003	

In this study, 53.3% patients with  $pH \leq 7$  and 72% patients with  $BD \geq 16$  needed oxygen support. A significant association was found between newborns

who needed oxygen support with pH (p value= 0.01) and BD (p value <0.0001). [Table 2]

**Table 2: Correlation of need for oxygen support with pH and base deficit**

Oxygen Support	pH		BD	
	$\leq 7$	$> 7$	$< 16$	$\geq 16$
	No. of Patients	No. of Patients	No. of Patients	No. of Patients
Present	16(53.3%)	8(13.33%)	6(9.2%)	18(72%)
Absent	14(46.67%)	52(86.67%)	59(90.7%)	6(24%)
Total	30(100%)	60(100%)	65(100%)	25(100%)
Mean $\pm$ SD	6.8 $\pm$ 0.22	7.12 $\pm$ 0.10	12.91 $\pm$ 4.21	19.73 $\pm$ 3.21
P-Value	0.01		<0.0001	

In this study, 51.7% patients with  $pH \leq 7$  and 70.8% patients with  $BD \geq 16$  required NICU stay. A highly significant association was found between newborns

who required NICU stay with pH (p value< 0.0001) and BD (p value <0.0001). [Table 3]

**Table 3: Correlation of NICU stay with pH and base deficit**

NICU stay	pH		BD	
	$\leq 7$	$> 7$	$< 16$	$\geq 16$
	No. of Patients	No. of Patients	No. of Patients	No. of Patients
Present	15(51.7%)	10(16.4%)	8(12.1%)	17(70.8%)
Absent	14(48.3%)	51(86.3%)	58(87.9%)	7(29.3%)
Total	29(100%)	61(100%)	66(100%)	24(100%)
Mean $\pm$ SD	7.09 $\pm$ 0.22		13.98 $\pm$ 4.30	
P-Value	<0.0001		<0.0001	

In this study, among 30 patients with  $pH \leq 7$ , 20% had RDS, 20% had TTNB, 3.3% had IUGR, polycythemia, neonatal sepsis, ascites, death after 3 days, thrombocytopenia, severe anemia. In this

study, among 60 patients with  $pH > 7$ , 10% had TTNB, 8.3% had polycythemia, 1.67% had RDS, IUGR, neonatal sepsis, seizures at 24 hours, hyperbilirubinemia, hypoglycemia, PPHN. [Table 4]

**Table 4: Correlation between complications and pH**

Complications	pH	
	$\leq 7$	$> 7$
	No. of Patients (%)	No. of Patients (%)
RDS	6(20%)	1(1.67%)
TTNB	6(20%)	6(10.0%)
Polycythaemia	1(3.3%)	5(8.33%)
IUGR	1(3.3%)	1(1.67%)
Neonatal Sepsis	1(3.3%)	1(1.67%)
Ascites	1(3.3%)	0(0.0%)
Death after 3 days	1(3.3%)	0(0.0%)
Thrombocytopenia	1(3.3%)	0(0.0%)
Severe Anaemia	1(3.3%)	0(0.0%)
seizures at 24 hours	0(0.0%)	1(1.67%)
Hyperbilirubinemia	0(0.0%)	1(1.67%)
Hypoglycaemia	0(0.0%)	1(1.67%)
PPHN	0(0.0%)	1(1.67%)

In this study, among 65 patients with  $BD < 16$ , 3.0% had RDS, 4.62% had TTNB, 3.3% had 6.15% polycythemia and 1.54% had neonatal sepsis, seizures at 24 hours, hyperbilirubinemia, hypoglycemia. In this study, among 25 patients with

$BD \geq 16$ , 36% had TTNB, 20% had RDS, 8% had polycythemia and IUGR, ascites, death after 3 days, neonatal sepsis, thrombocytopenia, severe anemia, PPHN. [Table 5]

**Table 5: Correlation between complications and BD**

Outcomes	BD	
	$< 16$	$\geq 16$
	No. of Patients (%)	No. of Patients (%)
RDS	2(3.0%)	5(20%)
TTNB	3(4.62%)	9(36%)
Thrombocytopenia	0(0%)	1(4%)
Polycythaemia	4(6.1%)	2(8%)
IUGR	0(0%)	2(8%)
Ascites	0(0%)	1(4%)

Death after 3 days	0(0%)	1(4%)
Neonatal Sepsis	1(1.5%)	1(4%)
Severe Anaemia	0(0%)	1(4%)
seizures at 24 hours	1(1.5%)	0(0%)
Hyperbilirubinemia	1(1.5%)	0(0%)
Hypoglycaemia	1(1.5%)	0(0%)
PPHN	0(0%)	1(4%)

## DISCUSSION

The Apgar score, initially proposed by Virginia Apgar in 1952, is a pragmatic approach for systematically evaluating neonates in the immediate postnatal period, with the aim of identifying individuals in need of resuscitation. The reduction of perinatal morbidity and mortality can be achieved by the identification and appropriate resuscitation of newborns at high risk. The correlation between significantly low Apgar scores and heightened prenatal morbidity and mortality has been proven by multiple authors. A significant risk factor for hearing impairment was identified as a low Apgar score, in conjunction with other factors such as a family history of deafness, anemia and hypertension in the antenatal care (ANC) setting, TORCH in the mother, and hyperbilirubinemia in infants.<sup>[10]</sup>

**Association of requirement of intubation and NICU stay with pH and base deficit:** Various factors contribute to the occurrence of fetal and neonatal acidemia in the uterus and during delivery. Maternal and fetal circumstances are the primary factors contributing to this phenomenon. Insufficient uterine blood flow and reduced placental perfusion can be attributed to various factors, including as severe maternal anemia, substantial blood loss, cardiovascular problems, and other disorders.<sup>[12]</sup> Umbilical cord compression and prolapse can result in diminished or obstructed blood circulation and oxygen supply, potentially leading to fetal metabolic or mixed acidosis, or even fetal demise within the uterus.<sup>[13]</sup> In this study, 20% patients in pH $\leq$ 7 group and 24% in BD $\geq$ 16 group patient required intubation. 53.3% patients with pH $\leq$ 7 and 72% patients with BD $\geq$ 16 needed oxygen support. 60% patients with pH $\leq$ 7 and 68% patients with BD $\geq$ 16 required NICU stay. In a retrospective cohort study, among 901 neonates, 39 were exposed to perinatal hypoxia with mean pH  $7.160 \pm 0.126$  and remaining were normal with mean pH  $7.314 \pm 0.083$  (p value < 0.001). Among 39, 4% required resuscitation (n = 36) including assisted ventilation (n = 32, 3.6%) performed, were transferred to neonatal intensive care unit (n = 15, 1.6%).<sup>[14]</sup>

In another study, among 1614 umbilical artery pH measurements. Thirty (1.9%) were having pH < 7. From this group, 23 infants were admitted to the neonatal intensive care unit, and 8 of them required intubation.<sup>[15]</sup>

**Association of neonatal complications with pH and base deficit**

In this study, complications were more associated in pH $\leq$ 7 and BD $\geq$ 16 groups with predominant

respiratory complications. 30 patients with pH $\leq$ 7, 20% had RDS, 20% had TTNB, 3.3% had IUGR, polycythemia, neonatal sepsis, ascites, death after 3 days, thrombocytopenia, severe anemia. among 25 patients with BD $\geq$ 16, 36% had TTNB, 20% had RDS, 8% had polycythemia and IUGR, ascites, death after 3 days, neonatal sepsis, thrombocytopenia, severe anemia, PPHN. A highly significant correlation was found between neonate complications with pH and BD.

In a study conducted by Goodwin TM et al,<sup>[16]</sup> it was shown that out of 126 full-term infants, 57% were admitted to the Neonatal Intensive Care Unit (NICU). Among these infants, 38% had pulmonary dysfunction, 26% had renal dysfunction, 31% had cardiac dysfunction, and 31% had HIE. A total of 5 newborn fatalities occurred. Out of the 109 cases whose umbilical arterial values were recorded, there was a notable rise in the occurrence of seizures among these newborns. The pH levels decreased from 9% with a pH of 6.90 to 6.99, to 80% with a pH of 6.61 to 6.70. A prevalence rate of 26% was observed for respiratory acidemia.

A study conducted by Morgan JL et al,<sup>[17]</sup> using retrospective cohort analysis revealed that out of 6970 singleton early preterm newborns, 1.8% were found to have metabolic acidemia. The presence of metabolic acidemia was found to dramatically enhance both neonatal mortality and morbidities associated with preterm. Included were ventilator requirement (73% versus 36%, p < 0.001), periventricular leukomalacia (5% versus 2%, p = 0.036), and neonatal death (13% versus 4%, p < 0.001).

In a separate investigation conducted by Gonen N et al,<sup>[18]</sup> it was demonstrated that the overall incidence of negative neonatal outcomes among a group of 3001 singleton cesarean deliveries was 14.43%. Furthermore, the study found that the ability of abnormal cord gas studies to predict composite adverse neonatal outcomes was extremely low, ranging from 0% to 2.07%, while its specificity was high, ranging from 97.2% to 99.9%.

## CONCLUSION

Neonatal complications and need for NICU stay observed within 7 days of life, were more prevalent in newborns with pH $\leq$ 7 and BD $\geq$  16 in umbilical cord arterial blood gas analysis showing highly significant correlation. Low APGAR score (<7) at 1 min, 5min, 10min was statistically significant in newborns with pH $\leq$ 7 and BD $\geq$  16 in umbilical cord arterial blood gas analysis.

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