Original Article

# Use of ABGA Parameters as predictive tool for Evaluation Of Outcomes Of Perinatal Asphyxia in Term And Preterm Newborns from central India: A Prospective Observational Study

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**Abstract**

**Background:** Perinatal asphyxia (PNA) is one of the three major cause of morbidity and mortality in India. ABG analysis may help to predict outcome of babies with Perinatal asphyxia. Aim of study was to identify Arterial blood gas analysis parameter as a predictor of outcome of newborns with perinatal asphyxia.

**Methods:** We included 144 newborns, with perinatal asphyxia who were born in our tertiary health care centre during March 2021 to September 2022. Extremely low birth weight babies and any baby with major congenital malformation were excluded from study. Babies were resuscitated in delivery room, then shifted immediately to NICU, stabilised and sample for arterial blood gas analysis (ABGA) was taken within first hour of life, then the babies were intervened accordingly. The outcomes were analyzed, correlated with the initial ABGA and compared among the study group.

**Conclusion:** We found that pH and HCO3 are better markers in predicting the outcome of perinatal asphyxia in newborns. HCO3 had the highest specificity (99.18%) followed by pH (97.54%). Discharge was higher with HCO3(mmol/L) >10 while death was significantly higher in HCO3(mmol/L)<10.This study gives an advantage over other studies conducted on cord blood sampling at birth as resuscitation of the baby is of more priority than sampling for the outcome while the amount of time taken for result and interpretation is the same. Along with the APGAR score, Arterial blood gas analysis within one hour can be used as a better predictive tool for outcome in newborns with perinatal asphyxia.

**Keywords:** ABGA, HCO3, newborns, Perinatal asphyxia, pH.

## Introduction

Perinatal asphyxia (PNA) is a lack of blood flow or gas exchange to or from the fetus in the period immediately before, during, or after the birth process.

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It is characterized by the marked impairment of exchange of respiratory gases (oxygen and carbon dioxide) leading, if prolonged, to progressive hypoxemia, hypercapnia, and significant metabolic acidosis (pH fall below 7). Despite the important advances in perinatal care in the past decades, asphyxia remains a severe condition leading to significant mortality and morbidity.

Children face the highest risk of dying in their first month of life, at a global rate of 19 deaths per 1,000 live births.Neonatal deaths account for 46% of all deaths among children under 5.In India neonatal death is still high, accounting for more than half of all under- five deaths and more than two-thirds of infant deaths. An estimated 62,000 newborns die every year in India and 50% of them die on 1st day of life[1].

The main causes of neonatal deaths are infection (33%), perinatal asphyxia (21%), and the consequence of prematurity/Low birth weight (LBW) and its related complications (21%)[2]. Immediate assessment of PNA includes umbilical pH, 1st hour post- delivery arterial blood gas analysis (ABGA), APGAR scores, and neurological changes ranging from twitching to hypotonia and seizures[3].Hypoxic Ischaemic encephalopathy (HIE) is clinically graded by Sarnat and Sarnat, Levene and Thompson score. The clinical grading system of HIE by Sarnat criteria has been proven to be a good determinant of neurological outcome[4]. Recent studies meta-analysis have shown a good association of cord ABG abnormalities (pH<7.0) with short-term (mortality, HIE, Ventricular hemorrhage) and long-term adverse outcomes (cerebral palsy)[5]. However, APGAR scores and acidosis have low sensitivity & positive predictive value for neurological injury & morbidity as per previous studies[6]. As resuscitation of the baby is of more priority than sampling cord blood for the outcome we planned to analyse Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and Diagnostic accuracy of ABGA parameters to predict outcome of babies with PNA.

The primary objective was to identify Arterial blood gas analysis parameters as a predictor of mortality of perinatal asphyxia. The secondary objective was to evaluate the outcome of term and preterm newborns with perinatal asphyxia intervened through ABGA.

## Material and Methods

This Prospective observational study was conducted fromMarch 2021 to September 2022 in Neonatal intensive care unit – Inborn unit, Department of Pediatrics at NSCB Medical College Jabalpur M.P. Ethical clearance was taken from Institute ethical committee (Number- IEC/2020/86) and a written informed consent was obtained from parents/guardian of all study subjects.

Inclusion criteria was newborns who have failed to initiate and sustain breathing at birth, metabolic acidosis in an early neonatal arterial blood sample (pH < 7.30) within the first hour of birth, and persistence of an APGAR score of <7 for longer than 5 minutes, All inborn newborns with PNA in whom sampling was done within one hour of birth. Exclusion criteria was Outborn babies, extremely low birth weight babies and babies with congenital anomalies.

The required sample size (N) was estimated using the formula $N = Z^2PQ / D^2$. Total 144 newborns were enrolled in the study based on sample size calculation. We obtained a detailed antenatal and perinatal history from reliable attendant of baby. Information about risk factors and any intervention done during delivery was obtained from attending obstretician. Baby was resuscitated immediately after birth and shifted to NICU.

Arterial sample was taken for Arterial blood gas analysis (ABGA) by peripheral artery catheterization within 1 hour of birth. Sample was processed in Automated Blood Gas Analyser (STAT PROFILE Prime) available in NICU, within 15 minutes of collection. Reference range for normal values for pH is 7.35-7.45, for HCO3 is 20-24 mEq/L, for PaO2is 50-70 mm Hg and for PaCO2 is 35-45 mm Hg.

**Definitions**

Sensitivity:

The sensitivity of a test is its ability to detect people who do have the disease.

Specificity:

The Specificity of a test is its ability to detect people who do not have the disease.

Positive Predictive value (PPV):

The PPV of a test is the proportion of positive results that are true positive, that is, the likelihood that a person with a positive test result truly has a disease.

Negative Predictive Value (NPV):

The NPV of a test is the proportion of negative results that are true negatives, that is, the likelihood that a person with a negative result truly does not have the disease.

Statistical analysis: Data was entered in Microsoft Excel sheet & analysed using statistical software SPSS- 25. Categorical variables were summarized in frequency tables with percentages, continuous variables were analyzed using Mean ± SD ormedian with the interquartile range as appropriate, and the chi-square or fisher exact test was applied. Paired t-test was applied for comparison between the two means. P-value <0.05 was considered significant.

## Results and Discussion

This study included 144 newborns admitted for birth asphyxia, 84(58.33%) were males & 60 (41.67%) were females. In majority [117(81.25%)] of study subjects mode of delivery was vaginal delivery. Lower Segment Caesarean Section (LSCS) was done in 27 (18.75%) cases. Birth weight was ≥ 2.5 kg in 71 (49.31%) cases , 1.51 to 2.49 kg in 62 (43.06%) cases &< 1.5 kg in only 11 (7.64%) cases. 122 (84.72%) newborns were of term (≥37 weeks) gestation & only 22 (15.28%) were preterm (<37 weeks).

APGAR score at 5 minutes was >5 in 77 (53.47%) newborns, followed by 5 in 54 (37.50%) newborns & only 13 (9.03%) out of 144 newborns had APGAR score <5 at 5 minutes of birth.

The majority [88(61.11%)] of neonates were discharged followed by being discharged on antiepileptic [34(23.61%)], whereas 22 out of 144 study subjects (15.28%) died.

In most [72(50.00%)] of neonates, the diagnosis was HIE-I, followed by HIE-II [56(38.89%)], shock [34(23.61%)], bleed [29(20.14%)], HIE-III [16(11.11%)], Acute Kidney Injury (AKI) [9(6.25%)], and Other{Congenital Heart Disease} in 6 (4.17%).

Association of outcome with pH is shown in Table 1.

**Table 1: Association of outcome with pH**.

| Outcome | <7.2(n=10) | 7.20 to7.29(n=110) | ≥7.3(n=24) | Total | P value |
|---|---|---|---|---|---|
| Discharge | 1(10%) | 69(62.73%) | 18(75%) | 88(61.11%) | <.0001* |
| Dischargeon antiepileptic | 2(20%) | 26(23.64%) | 6(25%) | 34(23.61%) | |
| Death | 7(70%) | 15(13.64%) | 0(0%) | 22(15.28%) | |
| Total | 10(100%) | 110(100%) | 24(100%) | 144(100%) | |

Association of diagnosis with pH is shown in Table 2.

**Table 2: Association of diagnosis with pH**.

| Diagnosisoutcome | <7.2(n=10) | 7.20 to 7.29(n=110) | ≥7.3(n=24) | Total | P value |
|---|---|---|---|---|---|
| HIE-I | 0(0%) | 57(51.82%) | 15(62.50%) | 72(50%) | 0.003* |
| HIE-II | 7(70%) | 40(36.36%) | 9(37.50%) | 56(38.89%) | 0.129 |
| HIE-III | 3(30%) | 13(11.82%) | 0(0%) | 16(11.11%) | 0.033* |
| AKI | 1(10%) | 8(7.27%) | 0(0%) | 9(6.25%) | 0.276 |
| Shock | 6(60%) | 28(25.45%) | 0(0%) | 34(23.61%) | 0.0002* |
| Bleed | 4(40%) | 21(19.09%) | 4(16.67%) | 29(20.14%) | 0.317 |
| Other{CHD} | 2(20%) | 4(3.64%) | 0(0%) | 6(4.17%) | 0.074 |

Association of outcome with HCO3 is shown in **Table 3.**

**Table 3: Association of outcome with $HCO_3$(mmol/L).**

| Outcome | <10(n=7) | 10 to15(n=87) | 15 to24(n=50) | Total | P value |
|---|---|---|---|---|---|
| Discharge | 0(0%) | 49(56.32%) | 39(78%) | 88(61.11%) | <.0001* |
| Discharge on antiepileptic | 1(14.29%) | 24(27.59%) | 9(18%) | 34(23.61%) | |
| Death | (85.71%) | 14(16.09%) | 2(4%) | 22(15.28%) | |
| Total | 7(100%) | 87(100%) | 50(100%) | 144(100%) | |

Association of diagnosis with HCO3 is shown in **Table 4.**

**Table 4: Association of diagnosis with $HCO_3$ (mmol/L).**

| Diagnosis Outcome | <10(n=7) | 10 to15(n=87) | 15 to24(n=50) | Total | P value |
|---|---|---|---|---|---|
| HIE-I | 0(0%) | 44(50.57%) | 28(56%) | 72(50%) | 0.018* |
| HIE-II | 3(42.86%) | 33(37.93%) | 20(40%) | 56(38.89%) | 0.958 |
| HIE-III | 4(57.14%) | 10(11.49%) | 2(4%) | 16(11.11%) | 0.002* |
| AKI | 0(0%) | 9(10.34%) | 0(0%) | 9(6.25%) | 0.052 |
| Shock | 7(100%) | 21(24.14%) | 6(12%) | 34(23.61%) | <.0001* |
| Bleed | 2(28.57%) | 18(20.69%) | 9(18%) | 29(20.14%) | 0.768 |
| Other{CHD} | (71.43%) | 1(1.15%) | 0(0%) | 6(4.17%) | <.0001* |

In majority [94(65.28%)] of neonates, $PaO_2$ (mmHg) was <60. $PaO_2$ was 60 to 70 in 25 neonates and >70 25 (17.36%) neonates. Association of outcome with $PaO_2$ was comparable in all groups.

In most [93(64.58%)] of neonates, $PaCO_2$ (mmHg) was <35 followed by 35 to 40 [45(31.25%)]. $PaCO_2$was >40 in only 6 out of 144 study subjects (4.17%). Shock was significantly higher in $PaCO_2$<35 (30.11%) and >40 (33.33%) as compared to 35 to 40 mmHg (8.89%). (p value=0.011).

Distribution of serum electrolytes and serum lactate was comparable in all groups.

Distribution of outcome was comparable with term/preterm birth & is shown in **Table 5.**

**Table 5: Association of diagnosis outcome with term/preterm.**

| Diagnosisoutcome | Term(n=122) | Preterm(n=22) | Total | P value |
|---|---|---|---|---|
| HIE-I | 57(46.72%) | 15(68.18%) | 72(50%) | 0.064 |
| HIE-II | 54(44.26%) | 2(9.09%) | 56(38.89%) | 0.002* |
| HIE-III | 11(9.02%) | 5(22.73%) | 16(11.11%) | 0.06 |
| AKI | 6(4.92%) | 3(13.64%) | 9(6.25%) | 0.141 |
| Shock | 24(19.67%) | 10(45.45%) | 34(23.61%) | 0.009* |
| Bleed | 20(16.39%) | 9(40.91%) | 29(20.14%) | 0.008* |
| Other{CHD} | 6(4.92%) | 0(0%) | 6(4.17%) | 0.591 |

$PaO_2$ (mmHg) had sensitivity of 77.27% followed by pH (31.82%), $HCO_3$(mmol/L) (27.27%) and $PaCO_2$(mmHg) (4.55%). On the other hand, $HCO_3$ (mmol/L) had specificity of 99.18% followed by pH (97.54%), $PaCO_2$(mmHg) (95.90%) and $PaO_2$(mmHg) (36.89%). As it is a dictum that increase in sensitivity will be accompanied by a decrease in specificity so we choose that variable as best in which combination of sensitivity and specificity gives the maximum predictive value. So, overall $HCO_3$ (mmol/L) and pH were best predictors of mortality. It is shown in **Table 6.**

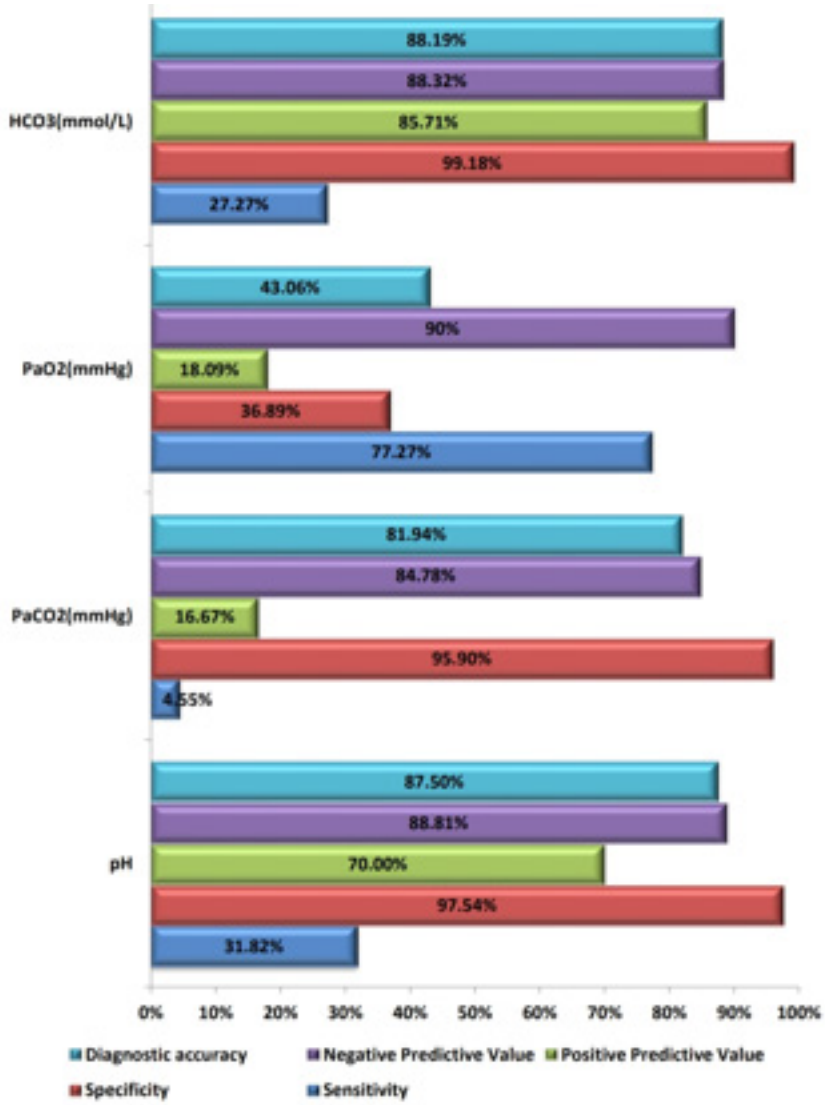


**Figure 1: Sensitivity, specificity, positive predictive value and negative predictive value of pH, $PaCO_2$(mmHg), $PaO_2$(mmHg) and $HCO_3$(mmol/L) for predicting mortality.**

In our study, out of 144 newborns with Perinatal asphyxia, 84 were male (58.33%) and 60 were female (41.67%) and there was no gender bias in ABG analysis. 81.25% of newborns were delivered via vaginal delivery, remaining were LSCS (18.75%). Since majority of deliveries at our centre were through vaginal, incidence of PNA was more in vaginal delivery compared to LSCS.

In our study, APGAR score at 5 minute was 5 to 7 in 53.47% of cases and 3-5 in 37.50% cases. Better outcome (survival) was reported in neonates with high APGAR score in comparison to low APGAR score similar to the study conducted by Murata et al.[7].Markedly lower rate of survival in APGAR (0-3) neonates beyond five minutes was reported by the study of Moster D et al[8].A 5-minute APGAR score of 0-3 correlates with very poor rate of neonatal survival in large populations also found in the different studies of Casey BM et al[9], Vahabi S et al[10] and Li F et al[11].

In our study, we found that majority of neonates (61.11%) were discharged followed by discharged on antiepileptic (23.61%). Only 15.28% study subjects died. Total 84.72% of neonates survived, nearly identical to Etuk SJ et al.[12], but lesser when compared to the studies done by Padayachee N et al.[13](86.7%).

(85.7%) In our study, in most of the cases (76.39%), pH was 7.20 to 7.29 followed by ≥7.3 (16.67%) while pH was <7.2 in only 6.94% study subjects. Death was significantly higher in pH <7.2

(70%) as compared to pH 7.20 to 7.29 (13.64%) and ≥7.3(0%). This is similar to study conducted by Malin GL et al.[5]and Gilstrap III LC et al[14].

We also found that, discharge was significantly higher with $HCO_3$(mmol/L) between 15-24, while discharge on antiepileptic was higher with $HCO_3$ between 10-15 and death was significantly higher in $HCO_3$<10 (P value 0.0001). A similar study by Saenz P et al[15],had a higher number of deaths at HCO3 <10. HIE-I was significantly higher with $HCO_3$(mmol/L) between 15-24 while HIE-II and HIE-III were higher with $HCO_3$(mmol/L) <10 similar to study conducted by Wyllie J at al[16].

In our study, complications of birth asphyxia like shock, bleeding and AKI were associated more with pH <7.2, HCO3 <10 &between 10-15, PaO2<60 mm Hg & PaCO2<35 mm Hg.HIE-I was associated more with PaCO2 <35 mmHg (52.69%) while HIE-II was more with PaCO2 >40(50%) and HIE-III were associated more with PaCO2 >40(16.66%). But the study conducted by Engle WD at al[17], hadmore incidence of HIE-II with PaCO2 >40(66%) and HIE-III (22%),as his study had cord blood samples.

Complications like shock, bleeding and AKI were higher in preterm newborns in our study(p=0.008) similar to the study conducted by Laptook AR et al[18].

## Conclusion

This study indicates that ABG Analysis can be used as a mortality predictor tool in birth asphyxia in neonates within one hour of birth. pH and HCO3 are better markers in predicting the outcome of birth asphyxia in neonates. PaO2 and PaCO2 have lesser sensitivity and specificity. This study gives an advantage over other studies conducted on cord blood sampling at birth asresuscitation of the baby is of more priority than sampling for the outcome while the amount of time taken for result and interpretation is the same. Along with the APGAR score, Arterial blood gas analysis within one hour can be used as a better predictive tool for outcomes in birth asphyxia neonates.

**Limitations of the study:** We were not able to consider socio-demographic factors during data analysis. Our study was conducted over a limited duration and did not involve any follow up. Hence long term outcomes were not assessed.

**What is already known:**

APGAR scores & low cord blood pH have low sensitivity & PPV for neurological injury and morbidity in newborns with perinatal asphyxia.

**What this study adds:**

Along with APGAR score, ABGA within one hour can be used as a better predictive tool for outcome in newborn with perinatal asphyxia.

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