Original article

Neonatal arterial blood gases & immediate outcome following perinatal asphyxia.

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Abstract:

Background: Perinatal asphyxia (PNA) remains a significant cause of death and disability despite the important advances in perinatal care in the past decades**.** Early neonatal mortality within the first 24 hours contributes substantially to overall neonatal mortality rates. Estimates of the incidence of perinatal asphyxia vary, in resource-rich countries is about 1/1000 live births and in resource-poor countries is probably much more common, an incidence of 5–10/1000 live births and represents the second most common cause of neonatal death (24%) after preterm birth related complications (35%). About one quarter of all neonatal deaths globally are caused by PNA & an equal number of serious neurological consequences ranging from cerebral palsy & mental retardation to epilepsy. ***Objective:*** To determine how well neonatal arterial blood pH and base deficit predict immediate outcome (survival to discharge) following perinatal asphyxia. ***Methods:*** This was a prospective study conducted in the delivery room and adjacent neonatal area (NICU) of Ad-din Medical College Hospital (AMCH), over 6 months from 1st June and 30th November, 2017. Research assistants were trained to observe and record events related to labor and neonatal resuscitation. Patient information was obtained which included patient characteristics (gender, birth weight & gestational age) and APGAR scores at and beyond 5 minutes. Within one hour of delivery all admitted neonates were subjected to an arterial blood gas (ABG) analysis by GEM Premier 3000 blood gas analyzer and pH and base deficit were noted. All the neonates were classified according to GA, BW and Gender. After proper cleaning the collected data were analyzed thoroughly. Descriptive analyses were performed; differences in outcome by GA, BW, Gender, APGAR scores and ABG (pH and base deficit) status were determined using analysis of variance. Analyses were performed using the Statistical Package for Social Sciences (SPSS) version (Chi-Square test). ***Results*****:** A total 50 neonates were studied in this period of which 72% survived & 28 % expired. Death was mostly observed in neonate who had very high level of base deficit (> 20mmol/L) & very low pH (pH <7.0) in 1st hour postnatal ABG. Survival rate was higher, 94.7% in >35 - <37 weeks GA group in comparison of ≥37 weeks (58%) of GA (p = 0.0050). The neonates with birth weight (BW) >2000 - <2500 gm were observed 77.78% survival and 68.75% in neonates with BW >2500gm (p = 0.494). In this study most of the neonates were male (70%) & recovery rate was relatively better among baby boys (74.3%) than baby girls (66.67%) (p = 0.582). High APGAR score neonates had better rate of recovery than poor APGAR score neonates. The neonates with APGAR score 4-6 beyond 5 minutes were observed 88.33% survival & the neonates with APGAR score 0-3 beyond 5minutes were 55% survival (p= 0.028). High pH value neonates in 1st hour ABG were found higher rate of survival in comparison to low pH value neonates. It was 83.33% in pH 7.10- <7.20 neonates, 72.73% in pH 7.0- <7.10 neonates and 33.33% in pH <7.0 neonates respectively (p=0.0136). The neonates with high level of base deficit in 1st hour ABG showed lower rate of survival than low level of base deficit neonates. It was 12.5% in base deficit > 20mmol/L neonates, 33.33% in base deficit > 15 - 20mmol/L neonates & 87.18% in base deficit ≥ 12 -15mmol/L neonates respectively (p=0.00003). ***Conclusion:*** From this study it is concluded that initial pH and base deficit of 1st hour ABG of neonates along with APGAR score at or beyond 5 minutes is a good predictor of risk & immediate outcome following perinatal asphyxia. A good percentage of neonates recover due to early diagnosis, meticulous nursing care and timely intervention.

Keywords: Perinatal asphyxia; ABG, pH; Base deficit

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Introduction:

Despite the important advances in perinatal care in the past decades, asphyxia remains a severe condition leading to significant mortality and morbidity. The term "asphyxia" is derived from the Greek and means "stopping of the pulse". Perinatal asphyxia (PNA) is a condition characterized by the marked impairment of exchange of the respiratory gases (oxygen and carbon dioxide) leading, if prolonged, to progressive hypoxemia, hypercapnia and significant metabolic acidosis (pH fall) [1]. It is also defined simply by the World Health Organization (WHO) as "the failure to initiate and sustain breathing at birth"[2]. Although more than 90% of neonates undergo smooth feto-neonatal transition, of the 10% who require some resuscitative assistance during delivery, a small minority requires extensive resuscitative effort[3]. The first 28 days of life – the neonatal period – are the most vulnerable time for a child's survival. 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 and in Bangladesh 20 per 1000 live births[4]. Neonatal deaths account for 46% of all deaths among children under 5. Globally 2.6 million children died in the first month of life—approximately 7 000 newborn deaths every day. The majority (75%) occurs during the first week of life, and about 1 million newborns die within the first 24 hours. The main causes of newborn deaths are preterm birth related complications (35%), intrapartum related events (24%), and serious infections (21%, sepsis or meningitis and pneumonia). These causes account for nearly 80% of deaths in this age group and almost all of these deaths occur in developing countries[4]. In Bangladesh 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 Bangladesh and 50% of them die on 1sr day of life[4]. The main causes of neonatal deaths are infection (33%), perinatal asphyxia (21%) and consequence of prematurity/Low birth weight (LBW) and its related complications (21%) [5]. Children who die within the first 28 days of birth suffer from conditions and diseases associated with lack of quality care at birth or skilled care and treatment immediately after birth. Perinatal asphyxia is a global serious clinical problem and 5-10% of all newborns need resuscitation at birth. It is remains a main killer of children under age 5 (12%) after preterm birth complications (18 %) and pneumonia (16%) others are diarrhoea (8%), neonatal sepsis (7%) and malaria (5%).[4] Estimates of the incidence of perinatal asphyxia vary, in resource-rich countries is about 1/1000 live births and in resource-poor countries is probably much more common, an incidence of 5–10/1000 live births[6]. Perinatal asphyxia remains a major cause of global mortality, contributing to almost one quarter of all neonatal deaths and an equal number of serious neurological consequences ranging from cerebral palsy and mental retardation to epilepsy[2, 7]. Perinatal asphyxia, a major factor contributing to perinatal and neonatal mortality, is an indicator of the social, educational and economic standards of a community. Immediate assessment of PNA includes umbilical pH, 1st hour post-delivery arterial blood gas (ABG), APGAR scores, and neurological changes ranging from twitching to hypotonia and seizures.[8]. When resources are lacking in developing countries, perinatal asphyxia can be crudely assessed by use of the APGAR score[8, 9]. However, APGAR scores and acidosis have low sensitivity & positive predictive value for neurological injury & morbidity [10, 11].

Objective:

To determine how well neonatal arterial blood pH & base deficit predict immediate outcome (survival to discharge) following perinatal asphyxia.

Material and Methods:

This was a prospective single centre study conducted in the delivery room and adjacent neonatal area (Neonatal Intensive Care Unit (NICU) of Ad-din Medical College Hospital (AMCH), over 6 months from 1st June and 30th November 2017. We obtained information from the neonates born at Ad-din Medical College Hospital (AMCH) and admitted here within 1 hours of birth with a fulfilling the following criteria: 1. The neonates, failure to initiate and sustain breathing at birth, 2. Metabolic acidosis in early neonatal arterial blood sample (pH < 7.20 and base deficit ≥ 12mmol/L) within first hour of birth, 2. Persistence of an APGAR score of <7 for longer than 5 minutes, 3. Neonates with birth weight (BW) >2000 g and 4.Gestational age (GA) > 35 weeks. Exclusion criteria included, (1) Mild metabolic acidosis in early neonatal arterial blood sample (pH > 7.20 & base deficit < 12mmol/L) within first hour, (2) GA < 35 weeks (3) BW < 2000 gm, (4) APGAR score 7 or more beyond 5 minutes & (5) Having major cardiac, pulmonary & surgically uncorrectable lethal anomalies.

All attending staff received training according to the neonatal resuscitation (NRP) guidelines by American Academy of Pediatrics (AAP) and American Heart Association (AHA), so that they could start appropriate resuscitation immediately.

These neonates received all other care including supplemental oxygen, fluids, anticonvulsants, nutrition and antibiotics as required.

Patient information was obtained which included patient characteristics (gender, birth weight & gestational age) & APGAR score at 5 and 10 minutes. Within one hour of delivery all admitted neonates were subjected to an arterial blood gas (ABG) analysis by GEM Premier 3000 blood gas analyzer and pH and base deficit were noted. Neonates were following up for immediate outcome like death or discharged. Over this period total 50 neonates were enrolled and classified according to GA, BW and Gender. A pretested preformed was used to record intricate details of each patient. Descriptive analyses were performed; differences in outcome by GA, BW, Gender, APGAR score and ABG (pH & base deficit) status were determined using analysis of variance. Analyses were performed using the SPSS version (Chi-Square test).

Ethical Clearance: Written consent from parents of neonates was taken in each cases and permission of ethical review committee of AMCH was also taken. After proper cleaning the collected data were analyzed thoroughly.

Results:

Total of 50 neonates were studied in this period among them 72% (n=36) survived and 28 % (n=14) expired. Death was mostly observed in neonate who had very high base deficit (> 20mmol/L) & very low pH (pH <7.0) in 1st hour ABG. There were 35 (70%) male & 15 (30%) female & ratio was 2.3:1.

Table: 1, showed the survival of neonates in relation to BW, GA & Gender. Gestational age was ranged from > 35 to 40 weeks; neonates of >35- < 37 weeks GA showed higher rate of survival in comparison of ≥37 weeks of GA, it was 94.7% in >35- <37 weeks GA & 58% in ≥37 weeks of GA (p = 0.005). The ranged of BW was >2000g to 3800g; the neonates with BW>2000 - <2500 gm were observed 77.78% survival & in BW >2500gm neonates it was 68.75% (p = 0.494). A relatively higher rate of survival was found among baby boys (74.3%) than baby girls (66.67%) (p = 0.582).

Table: 2, outcome of neonates based on APGAR score, high APGAR score neonates had better rate recovery than poor APGAR score neonates. The neonates with APGAR score 4-6 beyond 5 minutes were observed higher rate (88.33%) of survival than the neonates with APGAR score 0-3 beyond 5minutes (55%) (p = 0.0288).

Table: 3, observed pH in 1st hour ABG, it was ranged from 6.71 to <7.2. The survival rate was directly related with pH value, the neonates with high pH value were found higher rate of survival in comparison to low pH value neonates. It was 83.33% in pH 7.10- <7.20 neonates, 72.73% in pH 7.0- <7.10 neonates and 33.33% in pH <7.0 neonates respectively (p=0.0136)

Table: 4, denote the distribution and outcome of neonates on the basis of base deficit in 1st hour ABG, it was ranged from ≥12 to unrecordable base deficit. The recovery rate was inversely related with base deficit level, the neonates with high level of base deficit showed lower rate of survival than low level of base deficit neonates. It was 12.5% in base deficit >20mmol/L neonates, 33.33% in base deficit >15-20mmol/L & 87.18% in base deficit ≥12 -15mmol/L neonates respectively (p=0.00003).

Table 1: Distribution and outcome [N (%)] of the neonates according to neonatal characteristics (N=50).

Variables	Outcome of treatment		Total	p- value
Gestational Age (wk)	Survived (%)	Expired (%)		
>35- < 37 weeks	18 (94.7%)	01(5.3%)	19(100%)	0.0050
≥37 weeks	18 (58%)	13 (42%)	31(100%)	
Total	36 (72%)	14 (28%)	50 (100%)	
Weight (Kg)				
>2 – <2.5 Kg	14 (77.78%)	04 (22.22%)	18 (100%)	
>2.5 Kg	22 (68.75%)	10 (31.25%)	32 (100%)	0.494
Sex				
Male	26 (74.3%)	09 (25.7%)	35 (100%)	
Female	10 (66.67%)	05 (33.33%)	15 (100%)	0.582

Table 2: Distribution & outcome on basis of APGAR score beyond 5 minutes

Variables	Survival (%)	Expired (%)	Total	p- value
APGAR score 0-3 beyond 5 m	11 (55%)	09 (45%)	20 (100%)	0.0288
APGAR score 4 - 6 beyond 5 m	25 (83.33%)	05 (16.67%)	30 (100%)	
Total	36 (72%)	14 (28%)	50 (100%)	

Table 3: Distribution & outcome on basis of pH value (1ST hr ABG)

Variables	Survived (%)	Expired (%)	Total	p- value
pH- 7.10-<7.20	25 (83.33%)	5 (16.67%)	30 (100%)	0.0136
pH- 7.0- <7.10	8 (72.73%)	3 (27.27%)	11 (100%)	
pH- <7.0	3 (33.33%)	6 (66.67%)	09 (100%)	
Total	36 (72%)	14 (28%)	50 (100%)	

Table 4: Distribution & outcome on the basis of base deficit (mmol/L)

Variables	Survived (%)	Expired (%)	Total	p-value
Base deficit >20	1(12.5%)	7 (87.5%)	08 (100%)	0.00003
Base deficit>15-20	1(33.33%)	2 (66.67%)	03 (100%)	
Base deficit ≥12-15	34(87.18%)	5 (12.82%)	39 (100%)	
Total	36 (72%)	14 (28%)	50 (100%)	

Discussion:

Perinatal asphyxia- ''gasping or ineffective breathing or lack of breathing at one minute after birth''[12] remains a severe condition leading to significant mortality and morbidity despite the important advances in perinatal care in the past decades. And a major cause of global mortality, contributing to almost one-quarter of the world's 2.6 million neonatal deaths and an equal number of serious neurological consequences ranging from cerebral palsy and mental retardation to epilepsy[2,7].

A total 50 neonates were studied in this period among them 72% survived which was similar to study of Ann CL[13] (70%) but lesser when compared to the studies done by Padayachee N (86.7%)[14], by Etuk and Etak (85.7%)[15] ,Siva SSB et al (92%)[16], and Kumar et al (90%)[17]. Siva SSB et al and kumar et al studies showed a relatively high survival rate as in their study had mild perinatal asphyxia (HIE-I) around 31% and 81% respectively.

In this study the survival rate was more observed in near term (GA >35- <37 weeks) (94.7%), birth weight (> 2000gm - <2500gm) (77.78%) and male (74.3%) neonates in comparison to term (≥37 weeks), normal birth weight (>2500 gm) and female neonates. This study finding is opposite to that of other studies which shows that preterm, low birth weight and male neonates were more likely to die of perinatal asphyxia[13, 18]. The possible explanation is that term & normal birth weight neonates condition was very severe & had very severe acidosis (high base deficit >20mmol/L) & very low pH (pH <7.0) in their 1st hour ABG) at admission.

Better outcome (survival) was reported in high APGAR score neonates in comparison to low APGAR score[9]. In the present study the APGAR score (4-6) beyond 5 neonates showed higher rate of survival than low APGAR score (0-3) neonates, it was 83.33% and 55% respectively (p=0.028). Markedly lower rate of survival in APGAR (0-3) neonates beyond five minutes was reported by the study of Moster D et al[19], compared with neonates who had 5-minute APGAR scores of 7 to 10, neonates who had scores of 0 to 3 had a 386-fold increased risk for neonatal death[19]. 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[20] , Vahabi S et al[21](P = 0.0001) and Li F et al.[22]

The survival rate was directly related with pH value, the neonates with high pH value were found higher rate of recovery in comparison to low pH value neonates. The survival rate was 83.33% in pH 7.10 - <7.20 neonates, 72.73% in pH 7.0 - <7.10 neonates and 33.33% in pH <7.0 neonates respectively (p=0.0136). This finding is similar to the study of Siva

Saranappa S B et al[16], Casey BM et al[20] and Malin GL[23]. Casey BM et al[20] was found in their study, the risk of neonatal death in term infants was eight times with artery blood pH values of ≤7.0 and Malin GL[23] was found low arterial cord pH was significantly associated with neonatal mortality. Ambalavanan N et al, [24] observed among the neonates with cord pH of >6.70, those without spontaneous activity had worse outcomes (76% death), compared with those with such activity (32% death).

The recovery rate was inversely related with base deficit level, the neonates with high base deficit level showed lower rate survival than low base deficit level neonates. The survival was 12.5% in base deficit >20mmol/L neonates, 33.33% in base deficit >15-20mmol/L neonates & 87.18% in base deficit ≥12-15mmol/L neonates respectively (p=0.00003). This findings are relatively low comparable to the findings of Ambalavanan N et al, [24] where they found neonates with some activity had poor survival outcomes if the base deficit in the first postnatal arterial blood gas analysis was >18.5mmol/L (45% vs. 82% for ≤18.5mmol/L). Predictors for survival were base deficit in the first postnatal arterial blood gas analysis of >24.5mmol/L (28% survival) vs. ≤24.5mmol/L (79%). Also comparable with study of Trotman H and Garbutt A,[25] they were performed ABG on 43 of the neonates within 1 hour of delivery mean ± SD base deficit for neonates with good outcome was 14.4 ± 5.5mmol l^{-1} and those with poor outcome was 16.9 ± 5.7mmol l^{-1}.

Inspite of advances in the management of the various associated risk factors and the availability of NICU care, perinatal asphyxia still contributes to majority of the admissions in NICU and remains one of the commonest causes of neonatal deaths. Further prospective and case control studies will be required, to get more scientific ideas about perinatal asphyxia and to develop strategies for its prevention and management. Strict guidelines for early detection of risk factors, early referral of these high risk pregnancies in-utero, timely intervention of these high risk pregnancies and advanced NICU care can help in reducing the occurrence of birth asphyxia and hence mortality and morbidity in neonates.

Conclusions:

From this study it is concluded that initial pH and base deficit of 1st hour ABG of neonates along with APGAR score at or beyond 5 minutes is a good predictor of immediate outcome of Perinatal asphyxia. A good percentage of neonates survive due to early diagnosis, meticulous nursing care and timely intervention

Conflict of interest

All the authors declare no conflict of interest

Authors' Contribution:

Data gathering and idea owner of this study: Mannan MA, Dey S, Karim SMR

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Writing and submitting manuscript: Mannan MA, Dey S, Karim SMR, Iqbal S, Navila F

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