Correlation of blood gas status with the mortality of neonates admitted in ICU

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Abstract

Background : Blood gas abnormalities are frequently encountered in sick neonates admitted in ICU. They contribute significantly to mortality. Therefore, blood gas status is a helpful indicator of the condition of sick neonate.

Objective : To study the correlation between blood gas status and mortality of neonates admitted in ICU.

Methods : This observational study was carried out at the ICU of Dhaka Shishu Hospital (DSH) from January 2014 to July 2014. Total 121 neonates were enrolled according to inclusion criteria and analyzed their blood gas status which were correlated with the mortality of neonates.

Results : Perinatal asphyxia (PNA) was common disorder with the highest mortality in neonate followed by sepsis and pneumonia. Significant association between mortality with lower pH, PCO_2 and higher base excess was observed. Metabolic acidosis was the most common acid-base disorder.

Conclusion : Low pH, PCO_2 and more base excess are predictor of mortality in this group of neonate. Initial acid-base derangement significantly correlates with the mortality of critically ill neonates requiring ICU care.

Keywords : Blood gas analysis, perinatal asphyxia, metabolic acidosis.

DOI: http://dx.doi.org/10.3329/nimcj.v9i1.35924
Northern International Medical College Journal Vol. 9 No. 1 July 2017, Page 261-263

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Introduction

Understanding of hemoglobin-oxygen interactions and gas exchange provide cornerstone for clinical success to neonatal care. Critically ill neonate commonly have acid-base disorder which is a valuable indicator to a pediatrician about patient assessment, therapeutic decision and prognosis of the patient.[1] Blood gas analysis help in the diagnosis of metabolic and respiratory acidosis associated with birth process and with postnatal adaptation to air breathing.[1-2] The cardiovascular system undergoes changes after birth, respiratory gas exchange begins instead of formerly placental function, must be established by the lungs within minutes. Therefore, frequent and serious difficulties in cardio-respiratory adaptation in perinatal and neonatal periods are not surprising.[3]

Blood gas analysis provides pH, PCO_2 from which (HCO_3^-) and base excess (BE) can be derived.[4,5] Moreover, it is easily understandable and widely used at the bed side management.[6] This traditional approaches to analysis of acid-base status adapted from Handerson-Hasselbach equation mathematically links the variables of pH, PCO_2 and bicarbonate concentration (HCO_3).[7]

The PCO_2 concentration in a given patient reflects the balance between metabolic production of CO_2 and excretion by ventilation. The normal range of PCO_2 after the first hour of life can be considered 35-45 mmHg, pH value for a specific situation may be related to higher or lower PCO_2. Elevation of PCO_2 10 mmHg decreases pH by 0.08 while decrease of PCO_2 10mm Hg, increases pH by 0.08.[8,9]

In this regard marked structural and functional difference found in children in comparison to adults i.e children have narrow distal airways. Therefore, atelectasis develop quickly resulting in rapid-onset of hypercarbia and hypoxia. Chest wall is compliant and respiration is less efficient; the respiratory center is immature, hypoxia and hypercarbia lead to decreased respiratory drive. In addition they have reactive vascular bed to

maintain their blood pressure until late, therefore one cannot rely on hypotension to diagnose shock as in adults.[10] Hence blood gases provide essential information on acid-base status in critically ill neonates and predict their mortality.

Perinatal asphyxia and neonatal sepsis both are common occurrence in neonate and major health problems in Bangladesh like other developing countries and devastating cause of mortality. The acid-base abnormalities are common in perinatal asphyxia and neonatal sepsis, which need more vigorous measures to reduce their mortality in an emergency situation. Sometimes, perinatal asphyxia occurs when there is inadequate placental gas exchange to meet ongoing tissue needs for oxygen consumption and $C0_2$ elimination. The combination of lactic acidosis, product of anaerobic metabolism and $C0_2$ accumulation results in a mixed acidosis. It results most commonly from a drop in maternal blood pressure or some other substantial interference with blood flow to the infant's brain during delivery. This can occur due to inadequate circulation or perfusion, impaired respiratory effort, or inadequate ventilation.[11] An infant suffering from severe perinatal asphyxia usually has cyanosis, less perfusion, poor responsiveness reduce muscle tone and poor respiratory effort as reflected in low APGAR score (5-minute). Extreme degrees of asphyxia can cause cardiac arrest and death. Immediately after birth asphyxia, hypothermia generally lower metabolic rates and diminishes the glutamate levels in brain.[12-13] In neonatal sepsis, unstable temperature and less tissue perfusion leading to derangement of acid-base balance. Hence, it is desirable to have values corrected for patient temperature. Temperature affects pH, $PC0_2$ and $P0_2$.

This study was carried out in neonates with various ailments attending ICU at a tertiary care hospital of Dhaka, Bangladesh. The objective was to study acid-base status in common neonatal disease such as perinatal asphyxia, sepsis, pneumonia etc. and its relation with mortality.

Patients and Methods

This observational study was conducted at ICU, Dhaka Shishu (Children) Hospital during the period of January to July 2014. For each neonate, a detailed history from the mother or other care-giver was recorded in a preset questionnaire along with particulars of the neonates. Neonatal history included time of first cry or breathing immediately after birth, apnoea/cyanosis, convulsion, reluctant to feed and bleeding manifestation. Maternal history included antenatal care, prolonged rupture of the membranes (>12 hours before delivery was considered), prolonged second stage of labour, gestational age was determined from maternal records. Total 161 neonates admitted during this period among these 40 were excluded from this study due to any congenital anomaly,severely jaundiced due to blood group incompatibilities or received LAMA (Left against medical advice) and rest 121 were included in the study. Before enrollment parent of each child was given a detail explanation about the nature and purpose of the study. The study obtained ethical clearance by Bangladesh Institute of Child Health, Dhaka Shishu Hospital.

Enrolled neonates were analyzed for the blood gas status as well as baseline investigations as a part of management. With all aseptic precaution blood sample was obtained in the disposable syringe. Blood gas analyzer (Gastal-600) based on the principle of potentiometry analyzed pH, $PC0_2$ by respective electrodes. Base excess (BE) and (HCO_3-) were calculated from the parameters of pH and PCO_2 which were provided by the analyzer. All data were analyzed by SPSS version 20.

Results

In this study, 121 neonates (0-28 days), median age was 7 days. 84 neonates were male and 37were female, ratio 2.27:1. Among the admitted neonates most cases were PNA and Sepsis (Fig. 1).

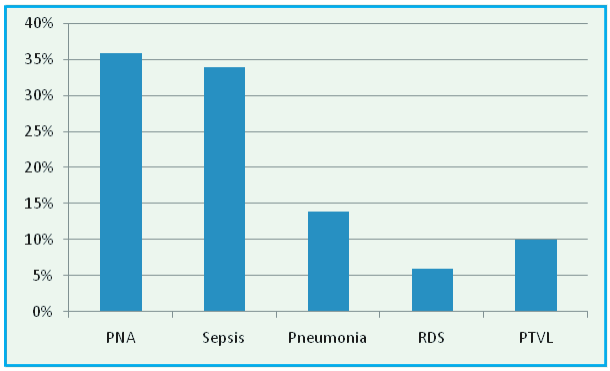

Fig 1: Diseases of ICU admitted neonate

For the analysis of data study neonates were divided into survival and non-survival groups. Initial observation of blood gas status in perinatal asphyxia and sepsis among survivors and non-survivors showed non- Survivors had less pH and more base excess level than survivors which were statistically significant (Table I). There was also statistical significant difference of blood gas status in perinatal asphyxia and sepsis among survivors and non-survivors at the end of the study. Non-survivors had less pH, HCO_3, PCO_2 and more base excess level than survivors which were statistically significant (Table II).

Table I : Acid-base parameters in Survivors and Non-survivors (Initial)

	Survivors (n =71) Mean ± SD	Non-Survivors (n =50) Mean ± SD	*P* value
pH	7.36 ±0.1	7.3 ±0.19	0.011^S
$PC0_2$ (mm of Hg)	31.69 ±11.54	33.63 ±17.48	0.466^{ns}
$HC0_3$ (mmo1/L)	18.03±6.59	17.95±10.4	0.961^{ns}
Base Excess	-4.3±6.88	-10.74±15.89	0.004^S

Table II : Acid base parameters in Survivors and Non-Survivors

	Survivors (n =71) Mean ± SD	Non-Survivors (n =50) Mean ± SD	*p* value
pH	7.4 ± 0.07	7.21 ± 0.22	0.001^S
PCO_2 (mm of Hg)	41.41 ± 13.23	26.39 ±12.12	0.007^S
HCO_3 (mmo1/L)	28.21 ± 9.37	18.71± 8.34	0.013^S
Base Excess	-3.82 ± 4.51	-13.21 ±12.4	0.001^S

Discussion

The study was carried out on the basis of neonates suffering from a wide variety of ailments attending ICU care. The selection was unbiased. Preponderance of males in this age group. Suffering from perinatal asphyxia, in accordance with the epidemiological pattern having the highest admission in the ICU was observed.

Arterial blood gas (ABG) sampling represents the gold standard method for acquiring patients acid-base status. Palsdottir K et al. evaluated the association between lower umbilical artery pH, more base deficit, and the development of hypoxic ischemic encephalopathy.[14] The majority of neonates with death had an arterial pH <7.00, therefore this would have had to occur in the majority of babies termed as acidosis paradox.[15] Acid-base disorders in critically ill neonatal ICU patients and predicting survival by the presence of deranged acid-base variables.[16] In this study lower mean pH in non-survivors was around 7.

An abnormal cord pH less than 7.2 immediately after birth can be used as a prognostic factor for unfavorable short term outcome in newborns. Now recommended in all high risk deliveries by both the British and American colleges of Obstetrics and Gynaecology.[17] Williams KP et al. suggest that severe fetal academia identified by a pH less than 7.0 was the most umbilical blood gas variable for predicting early onset of worst outcome e.g., seizures or mortality.[18] Goodwin TM et al. stated with worsening acidosis, mortality increases. They found that at pH<7.00 mortality occurs in 12%, 33% with cord pH<6.9,60% with pH <6.8, 80% with pH <6.7. No infant was live born with pH <6.6.[19]

Lekhwani S et al, &Broder G et al. showed significant correlation between outcome and critical value of pH <7.2 were associated with increase patient mortality.[20]

In sepsis, metabolic acidosis was found to be compensated by respiratory alkalosis. In this study low PCO_2 and HCO_3 were statistically significant in non-survivors compared with survivors. PC02 provides the most accurate determinations of alveolar ventilation.[8] This study has shown that metabolic acidosis (BE <5mmol/L) is one of the most frequent acid-base disorder occurring in non-survivors, similar to various studies (Lekhwani S et al.).[20] which remains a powerful marker of poor prognosis in critically ill patients.

Consequently, the management of acid-base disorder always demands precise diagnosis and treatment of the underlying disease, it requires steps to combat the deviation to reduce the mortality.[21] Nana W et al. showed low pH and high base deficit alone or in combination reflect an impaired condition e.g., bad outcome parameter at birth.[22] Similar to the present study, lower pH and higher base excess in non-survivors compared with survivors.

Conclusion

Blood gas status is a helpful indicator of the condition of sick neonate. Low pH, low PCO_2 and more base excess are predictor of mortality in this age group. Initial acid-base derangement significantly correlates with the ultimate outcome of critically ill neonates of ICU.

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