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ORIGINAL ARTICLE

Correlation of Acid-Base Status with Mortality of Neonates Admitted in PICU

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Abstract

Background: *The human organs and tissues function under a tightly controlled pH in the range of 7.35 to7.45. Depending on the degree of deviation of pH outside this narrow range, several homeostatic responses are activated in an effort to restore normal acid-base status.*

Objectives: *To study the acid-base disturbances in neonates admitted in PICU.*

Methods: *This study was conducted in Pediatric Intensive Care Unit (PICU) of Dhaka Shishu (Children) Hospital for a period of six monthsfrom January to June 2018. Hundred neonates attending pediatric emergency services with various ailments were curolled. Arterial blood gas (ABG) analysis was estimated in these neonates. Ethical committee approval was taken.*

Results: *Metabolic acidosis was the most common acid-base disorder. Fifty-seven neonates had metabolic acidosis.Significant correlation was observed between metabolic acidosis and pathological conditions like birth asphyxia and sepsis.*

Conclusion: *Metabolic acidosis is the most common acid base disorder in critically ill neonates.In this study it was the most common cause of mortality. If we do earlyintervention in correction of acid-base abnormality, the outcome is likely to get improved in neonates.*

Key words: *Acid-base disorders, ABG analysis, metabolic acidosis, birth asphyxia, sepsis.*

Introduction

Understanding of acid-base dysfunction in various pathological conditions is an asset to a pediatrician in efficient treatment of critically ill children.[1] Acid-base disorders reflect the seriousness of the underlying disease and are responsible for morbidity and mortality in children.[2] Marked structural and functional differences occur in children in comparison to adults, for example children have narrow distal airways, so atelectasis develops quickly resulting in rapid-onset of hypercarbia and hypoxia. In addition, they have reactive vascular beds to maintain their blood pressure until late, so one cannot rely on hypotension to diagnose shock as in adults.[3] In children the respiratory center is immature and respiration is less efficient, therefore hypoxia and hypercarbia lead to decreased respiratory drive. Disorders of acid-base balance can create complications in many disease states, and occasionally the abnormality maybe so severe so as to become a life-threatening risk factor.[4] Several factors impact the prognosis of patients with acid-base disturbances like severity of academia, acuity and duration of the derangement, functional status

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of the major organs especially lungs and kidneys, and last but not the least the underlying cause. Initially reactions by chemical buffers will attempt to neutralize the derangement, followed by ventilator adjustments by the lungs and finally alterations in acid excretion by the kidneys. Hence a thorough understanding of acid-base balance is mandatory for any physician and intensivist.[4] The utilization of an arterial blood gas (ABG) analysis becomes necessary in view of the following advantages: 1) aids in establishing diagnosis, 2) guides treatment plan, 3) aids in ventilator management, 4) improvement in acid/base management which in turn allows for optimal function of medications, and finally 5) acid-base status may alter electrolyte levels that may be critical to a patient's status.[4]

Identification of the underlying cause or causes of the acid-base disorder at hand may be the final step in the management of the patients but it also plays an important role both in prevention of worsening of the derangement and other complications, as well as in the determination of the patients' overall prognosis.[5] The main objective of our study was to identify the acid-base disturbances in neonates admitted in our Paediatric Intensive Care Unit.

Materials and Methods

The study was conducted at Pediatric Intensive Care Unit, Dhaka Shishu (Children) Hospital for a period of six months from January to June 2018. This hospital is a tertiary care centre for both pediatric and neonatal cases.

One hundred neonates admitted in PICU with various ailments were included in this study. Blood Gas analysis was estimated in these neonates who require ABG report as part of the management by pediatrician. Cases were selected unbiased in our study.

Detailed history was recorded in every case and was compiled from history sheet. Physical findings were recorded from history sheet. Investigation reports were collected from the record sheet and relevant reports were analyzed. For all of the cases in our study either ulnar or radial artery was punctured for ABG analysis. Investigations like blood counts, blood cultures, metabolic profile, serum electrolytes, Color Doppler Echocardiography etc. were done according to the condition of the baby.

Results

This study was carried out over a period of 3 months. The median age of patients was 2 days. The male to female ratio was 1.38:1 (58 males to 42 females). There was no correlation between either age or sex and severity of acid-base disturbances in this study.

Comparative observation of acid-base parameters among term- and preterm neonates with major diagnosed pathological conditions (birth asphyxia, sepsis etc.) are shown in Figure-1. There was a significant correlation (P value less than 0.05)

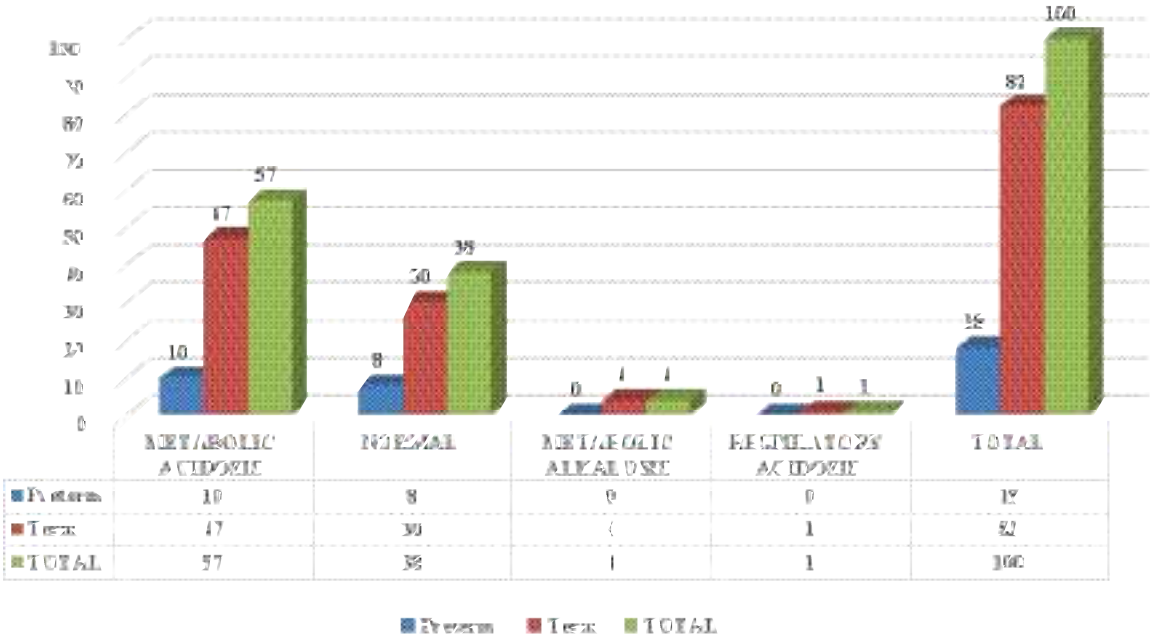

Fig 1 *Comparative observation of acid-base parameters among term- and preterm neonates with major diagnosed pathological conditions (N=100)*

Table I
Significant correlation was found between outcome and various diagnosed pathological conditions (N=100)

Particulars	Sepsis	Birth Asphyxia	Others	Total	p value
Metabolic acidosis	15	25	17	57	0.017
Metabolic alkalosis	1	0	3	4	0.001
Respiratory acidosis	1	0	0	1	0.000
Normal	12	7	19	38	0.011
Total	29	32	39	100	

between outcome and various diagnosed pathological conditions where metabolic acidosis was found in 57 neonates. Birth asphyxia (32 cases) followed by sepsis (29 cases) were associated major pathologic conditions (Table I). Decrease in pH was observed in 40 of such cases, 38 neonates admitted in the emergency area had normal arterial blood gas parameters while 4 neonates had metabolic alkalosis. Only one case developed respiratory acidosis in this study.

Table II shows the number of cases admitted with different pathological conditions that were studied for the acid-base disorders. Among the 13 neonates which were admitted for respiratory distress syndrome, only 5 cases had metabolic acidosis and the remaining 8 neonates had normal ABG analysis. Out of the 4 neonates who developed metabolic alkalosis, 2 had amniotic fluid gastritis, one had paralytic ileus and one neonate suffered from sepsis. Only one case in our study, who was admitted with sepsis, had respiratory acidosis.

Table II
Number of cases admitted with different pathological conditions that were studied for the acid base disorders (N=100)

Diagnosis	Frequency	Percent
Birth asphyxia	36	36
Sepsis	29	29
RDS	14	14
HDN	11	11
Diaphragmatic hernia	3	3
DIC	3	3
Congenitalpneumonia	2	2
Patentductusarteriosus	1	1
URTI	1	1
Total	100	100

Overall mortality rate was 18%. Among the patients who had metabolic acidosis, metabolic alkalosis and respiratory acidosis, 24.6%, 75% and 100% patients respectively died. The mortality in patients with metabolic derangements were significantly higher p <0.05) (Table III).

Table III
Outcome of enrolled cases based on acid base status (N=100)

Metabolic abnormality	Total	Survived	Died	p value
Metabolic acidosis	57	43	14	0.038
Metabolic alkalosis	04	01	03	0.008
Respiratory acidosis	01	00	01	0.004
Normal	38	38	00	
Total	100	82	18	

Discussion

The study was done on neonates suffering with different pathological conditions, admitted in the neonatal emergency services. Male babies were more in our study though this gender difference had no significant correlation with the purpose of this study. However it only signified an epidemiological pattern in the region. Similar inference was made in study byLekhwanietal.[1]The acid-base status in major pathological disorders such as birth asphyxia, bronchopneumonia, sepsis, Hemolytic disease of the newborn (HDN), amniotic fluid gastritis etc. occurring in infants and neonates is discussed as follows.[6] In our study, birth asphyxia constituted major cause of admission among neonates. Sepsis is the second most common cause for admission in neonates. Metabolic acidosis is the predominant

acid-base abnormality which was established in this study. In this study out of 32 neonatal cases admitted for birth asphyxia, 25 neonates had metabolic acidosis. Similarly 15 out of 29 neonates admitted for sepsis have shown a picture of metabolic acidosis on ABG analysis. Similar results were also seen the studies made by Lekhwani etal.[1] Seventeen neonates admitted with other conditions like bronchopneumonia, cardiac diseases and respiratory distress syndrome (RDS), etc. were also reported to have metabolic acidosis. All the three cases of congenital diaphragmatic herniahad metabolic acidosis in this study. Among the 13 neonates who were admitted for respiratory distress syndrome, only 5 cases had metabolic acidosis and the remaining 8 neonates had normal ABG analysis. Out of the 4 neonates who developed metabolic alkalosis, 2 had perinatal asphyxia, one had paralytic ileus and one neonate suffered from sepsis. In this regard marked structural and functional difference found in children in comparison to adults i.e., children have narrow distal airways.[3] Therefore, atelectasis develops 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.[3] 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 CO_2 elimination.

The combination of lactic acidosis, product of anaerobic metabolism and CO_2 accumulation results in a mixed acidosis. This can occur due to inadequate circulation or perfusion, impaired respiratory effort, or inadequate ventilation.[7] 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.[8,9] 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. The study was carried out on the basis of neonates suffering from a wide variety of ailments attending ICU care. Suffering from perinatal asphyxia, in accordance with the epidemiological pattern having the highest admission in the ICU was observed. 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.[10,11]Only one case in our study which was admitted with sepsis had respiratory acidosis. Thus in our study it was noted that the major acid-base disorder was the metabolic acidosis which was statistically significant. The present study shows that ABG measurement may give important prognostic information and early warning signals.

Ahmad et al[12] showed that acid-base disorders in critically ill neonates reflect an impaired condition e.g., bad outcome parameter, similar to the present study, where acid-base abnormalities were significantly higher in non-survivors compared with survivors.

Conclusion

Acid-base disorders need to be anticipated in all the critically ill neonates. Vigorous monitoring of the acid-base status will help in early recognition of the underlying cause and also help in prevention of a life threatening state. Metabolic acidosis was the most common acid-base disorder in this study and mortality is high among these babies.

References

1. Lekhwani S, Shanker V, Gathwala G, Vaswani ND. Acid-base disorders in critically ill neonates. *Indian J Crit care Med* 2010;**14**:65-69.

2. Rocktaeschel J, Morimatsu H, Uchino S, Goldsmith D, Poustie S, Story D, et al. Acid-base status of critically ill patients with acute renal failure: analysis based on Stewart-Figge methodology. *Crit Care* 2003;**7**:60-66.

3. Otieno H, Were E, Ahmed I, Charo E, Brent A, Maitland K. Are bedside features of shock reproducible between different observers? *Arch Dis Child* 2004;**89**:977-79.

4. Sood P, Paul G, Puri S. Interpretation of Arterial Blood Gas. *Indian J Crit Care Med* 2010; **14**:57-64.

5. Al-Khadra E. Disorders of the Acid-Base Status. In: Kiessling SG, Goebel J, Somers MJG (eds.) Pediatric Nephrology in the ICU. Springer, Berlin, Heidelberg; 2009. pp.19-33.

6. Das B. Acid-base disorders. *Indian J Anaesth* 2003;**47**:373-79.

7. Abelow B. Understanding Acid-Base. Baltimore: Williams and Wilkins; 1998.P.52-54.

8. Engidawork E, Loidl F, Chen Y, Kohlhauser C, Stoeckler S, Dell'Anna E, et al. Comparison between hypothermia and glutamate antagonism treatments on the immediate outcome of perinatal asphyxia. *Exp Brain Res* 2012;**138**:375-83.

9. Berger R, Garnier Y. Perinatal brain injury. *J Perinatal Med* 2000;**28**:261-85.

10. Kellum JA. Clinical review: reunification of acid-base physiology. *Crit Care* 2005;**9**:500-07.

11. Sirker AA, Rhodes A, Grounds RM, Bennett ED. Acid-base physiology: the 'traditional' and the 'modern' approaches. *Anaesthesia* 2002;**57**:348-56.

12. Ahmad I, Ahmed A, Roy S. Acid Base Disorders in Critically Ill Neonatal Intensive Care Patients and Predicting Survival by the Presence of Deranged Acid-Base Variables. *J Neonatal Biol* 2015:**5**:207.