Original Research Article

DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20200673

Base excess as a prognostic factor determining the perinatal outcome

Chandrakala P., Shilpa Deborah Lysander*, Jayalalitha

Department of Pediatrics, Kempegowda Institute of Medical Science, Bangalore, Karnataka, India

Received: 17 December 2019 Revised: 05 January 2020 Accepted: 28 January 2020

*Correspondence:

Dr. Shilpa Deborah Lysander, E-mail: shilpalysander@gmail.com

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ABSTRACT

Background: Umbilical cord blood gas assessment seems to be the most objective determination of fetal metabolic condition at the time of birth and can be used to assess the perinatal outcome of the baby. In the early stage of an impaired placental circulation, hypoxemia and hypercapnia result in a decrease in pH with BD maintained normal (respiratory acidemia), whereas if the hypoxic process develops into a sustained anaerobic metabolism the BD rises secondary to lactic acidosis and consumption of buffer.

Methods: Observational study done in KIMS hospital Bangalore, Karnataka, India, in a study period of 18 months on a sample size of 100. Within 30 sec of delivery a segment of umbilical cord was clamped at both ends. Cord blood was collected in heparinised syringe. It was then transported with cold ice packs and blood pH, pCO₂, pO₂ were measured.

Results: In present study, there was a significant difference between the 2 groups in terms of BE, BE being highest in the group without complication. There was a moderate negative correlation between duration of NICU stay (days) and BE (mmol/L), and this correlation was statistically significant. There was a significant difference between the 2 groups in terms of BE with the median BE (mmol/L) being highest in the group not requiring resuscitation. At a cutoff of BE (mmol/L) <-17.5, it predicts complications with a sensitivity of 71.4%, and a specificity of 88.2%.

Conclusions: Hence cord blood base excess can be used as a prognostic factor in determining the perinatal outcome.

Keywords: ABG, Base excess, Metabolic acidosis, Perinatal complications

INTRODUCTION

Umbilical cord blood gas analysis at birth provides a retrospective objective measure of the fetus' aerobic and anaerobic intrauterine metabolism, used not only to assess the course of labor and management in individual births, but also as an important measure in cases of litigation, in education, for quality assurance of maternity units, and as an outcome parameter in clinical research. The ability of pH and BD to reflect a depressed vitality at birth has been addressed also in other studies, where some have shown pH to be better than BD, some have shown it to be equally good (or bad), but none show that BD is better than pH. In contrast to Knutzen et al in a recent review argue that BD is the most important

variable for reflecting neonatal morbidity.¹ They stated that a cord artery pH of <7 is a practical threshold for defining pathological fetal acidemia, but that pH alone is not a strong interpreter of neonatal outcome because only acidosis with a metabolic component is associated with an increased risk of neonatal morbidity or mortality.

Many physicians might be unaware of the fundamental principle of fluid compartment when assessing cord blood BD. In contrast to adults, in the hypoxic fetus there could be a fairly large difference in BD value when calculated in blood and when calculated in ECF, but few researchers have recognized that BD in blood (BDblood) and BD in ECF (BDecf) are calculated differently and

that different blood gas analyzers use different algorithms to calculate BD. ^{2,3}

The rationale for adding BD to pH determinations is to distinguish between respiratory and metabolic acidemia. In the early stage of an impaired placental circulation, hypoxemia and hypercapnia result in a decrease in pH with BD maintained normal (respiratory acidemia), whereas if the hypoxic process develops into a sustained anaerobic metabolism the BD rises secondary to lactic acidosis and consumption of buffer. Metabolic acidosis is in obstetrics defined as a low umbilical cord pH (usually 12.0 or > 16.0 mmol/L). The threshold BD > 12.0 mmol/L, with no reference to blood or ECF, was established by Low et al.4 In any case, a large majority of acidemic newborns are vigorous and in the absence of neurological symptoms they appear not to run an increased risk of developing neurologic or behavioral problems later in life.5

In labor, there is an increase in metabolic acidosis, with a base deficit of -4.8 mEq/l and a standard bicarbonate of 20.3 mEq/l, due to maternal fixed acids from uteroplacental metabolism and from ketone bodies which appear with stress; in fetal acidosis the umbilical artery has been shown to contain high levels of lactic and pyruvic acids.⁶⁻⁹

METHODS

Materials and method

- Study area: Department of peadiatric, KIMS
- hospital, Bangalore, Karnataka, India
- Study design: Observational study
- Study subjects: neonates delivered at Kempegowda
- Institute of Medical Sciences
- Study period: 12 months
- Sample size: 100

Inclusion criteria

- Complicated pregnancies
- Abnormal NST
- Meconium stained amniotic fluid
- Prolonged labour
- Neonates with low APGAR score at birth.

Exclusion criteria

Normal antenatal history with normal Apgar score.

Informed consent from the mother. The standard technique of sampling cord blood for gas and acid-base analysis comprises three steps:

- Clamping a segment of the cord
- Removing the clamped cord segment

 Needle aspiration of venous blood sample from the excised clamped cord segment was done and later transferred into preheparinized syringes.

An approximate 20cm segment of cord must be isolated between two sets of two clamps and 0.5ml of the venous blood is aspirated and transferred to preheparinized syringe. The sample was transported with ice packs. Delay in clamping resulted in significant change in acid-base parameters the longer the delay, the greater is the change. The change was a progressive decrease in pH and base excess and increase in pCO2 and lactate.

Statistical analysis

Data were coded and recorded in MS Excel spreadsheet program. SPSS v23 was used for data analysis. Appropriate non-parametric tests (Wilcoxon test/Kruskal Wallis Test/Spearman Correlation) were used when the data were non-normally distributed. ROC analysis was performed to find the best cut-off for diagnosing the outcome condition. Level of significance was taken as p<0.05.

RESULTS

The variable BE (mmol/L) was not normally distributed in the 2 subgroups of the variable Complications. Thus, non-parametric tests (Wilcoxon Test) were used to make group comparisons.

Table 1: Comparison of complications in terms of base excess (mmol/L).

BE (mmol/L)	Complications		Wilcoxon test	
	Present	Absent	W	p-value
Mean (SD)	-17.57	-12.71	1.47.000	0.016
	(5.41)	(4.17)		
Median(IQR)	-20 (6.5)	-13 (6)	147.000	
Range	-239	-193		

There was a significant difference between the 2 groups in terms of BE (mmol/L) (W=147.000, p=0(.016), with the median BE (mmol/L) being highest in the group without complication.

The above scatterplot depicts the correlation between duration of NICU stay (days) and BE (mmol/L). Individual points represent individual cases. The blue trendline represents the general trend of correlation between the two variables. The shaded grey area represents the 95% confidence interval of this trendline.

Non-parametric tests (Spearman Correlation) were used to explore the correlation between the two variables, as at least one of the variables was not normally distributed.

There was a moderate negative correlation between duration of NICU stay (days) and BE (mmol/L), and this

correlation was statistically significant (rho=-0.39, $p\le0.001$).

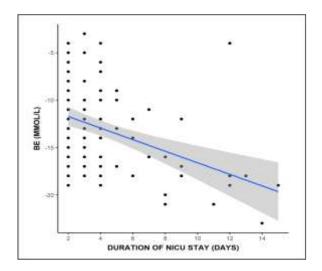


Figure 1: Correlation between duration of NICU stay (days) and base excess (mmol/L).

For every 1 unit increase in Duration of NICU Stay (Days), the BE (mmol/L) decreases by 0.61 units.

Table 2: Comparison of resuscitation required in terms of base excess (mmol/L).

Base	Resuscitation		Wilcoxon test	
excess (mmol/L)	Required	Not required	W	p-value
Mean (SD)	-16.08 (3.91)	-12.09 (4.14)		0 <0.001
Median (IQR)	-17 (6.25)	-12 (6.25)	444.000	
Range	-239	-193	•	

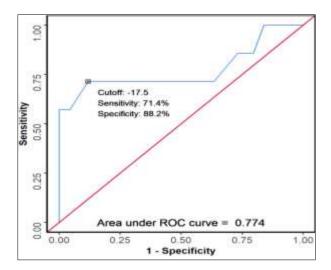


Figure 2: ROC curve analysis showing diagnostic performance of base excess (mmol/L) in predicting complications: present versus complications: absent.

The variable BE (mmol/L) was not normally distributed in the 2 subgroups of the variable Resuscitation. Thus, non-parametric tests (Wilcoxon Test) were used to make group comparisons.

There was a significant difference between the 2 groups in terms of BE (mmol/L) (W=444.000, p≤0.001), with the median BE (mmol/L) being highest in the group not requiring resuscitation.

The area under the ROC curve (AUROC) for BE (mmol/L) predicting complications: present versus complications: absent was 0.774 (95% CI: 0.505-1), thus demonstrating fair diagnostic performance. It was statistically significant (p=0.016).

At a cutoff of BE (mmol/L) <-17.5, it predicts complications with a sensitivity of 71.4%, and a specificity of 88.2%.

DISCUSSION

In present study done in KIMS hospital Bangalore, Karnataka, India, in a sample size of 100 it was noted there was a significant difference between the 2 groups (those with complication and those without complications) in terms of BE (mmol/L) (W=147.000, p=0.016), with the median BE (mmol/L) being highest in the group without complication.

In a study done by Victory R et al, undertaken to determine the relationship of umbilical cord pH and base excess (BE) values to adverse neonatal outcomes for a large tertiary hospital population delivering at term, a progression of risk in term infants for Apgar less than 7 at 5 minutes, NICU admission, and need for assisted ventilation with worsening acidosis at birth, which begins with cord blood values close to mean values indicating a higher threshold for associated acidemia with these outcomes than is seen for more severe neonatal outcomes.¹⁰

In a study done by Wiberg N et al, lactate in cord arterial blood is at least as good as BD to indicate a depressed vitality at birth, particularly in combination with pH and best used with Gestational age-adjusted values, but for any conclusion about the predictive value on long-term outcome further studies are needed. 11

In present study, there was a moderate negative correlation between duration of NICU stay (days) and BE (mmol/L), and this correlation was statistically significant (rho=-0.39, $p\le0.001$).

There was a significant difference between the 2 groups (those requiring resuscitation and those not requiring resuscitation) in terms of BE (mmol/L) (W=444.000, $p\le0.001$), with the median BE (mmol/L) being highest in the group not requiring resuscitation.

At a cutoff of BE (mmol/L) <-17.5, it predicts Complications with a sensitivity of 71.4%, and a specificity of 88.2%.

CONCLUSION

Hence, cord blood base excess can be used as a prognostic factor in determining the perinatal outcome.

ACKNOWLEDGEMENTS

Authors would like to thank their beloved teacher Dr. Srinivasa, H.O.D. and professor, Department of Paediatrics, for his constant encouragement and support throughout the study.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

Institutional Ethics Committee

REFERENCES

- 1. Knutzen L, Svirko E, Impey L. The significance of base deficit in acidemic term neonates. Am J Obstet Gynecol. 2015;213(3):373.e1-373.e7.
- 2. Wiberg N, Källén K, Olofsson P. Base deficit estimation in umbilical cord blood is influenced by gestational age, choice of fetal fluid compartment, and algorithm for calculation. Am J Obstet Gynecol. 2006;195(6):1651-6.
- 3. Mokarami P, Wiberg N, Olofsson P. An overlooked aspect on metabolic acidosis at birth: blood gas analyzers calculate base deficit differently. Acta Obstet Gynecol Scand. 2012;91(5):574-9.
- 4. Low JA. Intrapartum fetal asphyxia: definition, diagnosis, and classification. Am J Obstet Gynecol. 1997;176(5):957-9.

- 5. Hafstrom M, Ehnberg S, Blad S, Noren H, Renman C, Rosen KG, et al. Developmental outcome at 6.5 years after acidosis in term newborns: a population-based study. Pediatrics. 2012;129(6):e1501-7.
- Utility of umbilical cord blood acid-base assessment. ACOG committee opinion: committee on obstetric practice. Number 138--April 1994. Int J Gynaecol Obstet. 1994;45(3):303-4.
- 7. Goldaber KG, Gilstrap LC. Correlations between obstetric clinical events and umbilical cord blood acid-base and blood gas values. Clin Obstet Gynecol. 1993;36(1):47-59.
- 8. Low JA. The role of blood gas and acid-base assessment in the diagnosis of intrapartum fetal asphyxia. Am J Obstet Gynecol. 1988;159(5):1235-40.
- 9. Hagelin A, Leyon J. The effect of labor on the acidbase status of the newborn. Acta Obstet Gynecol Scand. 1998;77(8):841-4.
- Victory R, Penava D, Da Silva O, Natale R, Richardson B. Umbilical cord pH and base excess values in relation to adverse outcome events for infants delivering at term. Am J Obstet Gynecol. 2004;191(6):2021-8.
- 11. Wiberg N, Källén K, Herbst A, Olofsson P. Relation between umbilical cord blood pH, base deficit, lactate, 5-minute Apgar score and development of hypoxic ischemic encephalopathy. Acta Obstet Gynecol Scand. 2010;89(10):1263-9.

Cite this article as: Chandrakala P, Lysander SD, Jayalalitha. Base excess as a prognostic factor determining the perinatal outcome. Int J Contemp Pediatr 2020;7:516-9.