

Study on umbilical cord arterial blood gas analysis and cord blood lactate levels as predictors for adverse neonatal outcome: an observational study

Suman Shivanagouda Patil^{1*}, Sukanya¹, Suman Rath², Carolin Elizabeth George³

¹Department of Obstetrics and Gynecology, ²Department of Pediatrics, ³Department of Community Medicine, Bangalore Baptist Hospital, Bangalore, Karnataka, India

Received: 20 January 2018

Accepted: 28 February 2018

***Correspondence:**

Dr. Suman Shivanagouda Patil,
E-mail: sumidoc4u@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Perinatal asphyxia is a major cause of neonatal and childhood morbidity and mortality. Electronic foetal monitoring is used routinely to know the condition of the baby during Intrapartum period. Normal trace correlates highly with absence of acidemia at birth. Abnormal trace needs further evaluation. In order to better define the metabolic status of the new born, umbilical lactate levels have been measured. Objectives of this study were to determine the validity of umbilical cord blood lactate levels in predicting the adverse early neonatal outcome in babies with intrapartum foetal distress and to compare the validity of umbilical cord blood lactate and umbilical artery pH in predicting adverse neonatal outcome in babies with intrapartum foetal distress.

Methods: 295 pregnant women with abnormal CTG in active labour were subjected for estimation of cord blood lactate and umbilical artery pH immediately after delivery and were compared in predicting adverse neonatal outcome.

Results: In the present study specificity of serum lactate (97.7%) and umbilical artery pH (95.97%) was almost similar in babies with Apgar <7 at 1 minute and 5 minutes, but sensitivity of serum lactate (23.14%) and cord ph (31.4%) was less in babies with Apgar score ≤7 at 1 minute. Area under ROC showed serum lactate is more accurate in predicting adverse neonatal outcome compared to umbilical artery pH.

Conclusions: Umbilical cord blood lactate is more specific than umbilical artery pH in predicting adverse neonatal outcome. Area under ROC (at 95th percentile) shown serum lactate is more accurate in predicting adverse neonatal outcome compared to umbilical artery pH at birth.

Keywords: Fetal distress, Hypertension in pregnancy, Stillbirths

INTRODUCTION

Labour is a stressful event for the fetus. Foetal distress has been described as “a condition in which foetal physiology is so altered to make death or permanent injury a probability within a relatively short period of time and usually considered to denote disruption of normal foetal oxygenation, ranging from mild hypoxia to profound foetal asphyxia”.¹

Perinatal asphyxia is a major cause of neonatal and childhood morbidity and mortality.

WHO states that about 9 million neonates develop birth asphyxia every year, of them 1.2 million die and same number develop severe consequences like cerebral palsy, epilepsy and delayed developmental milestones. Considerable studies have been done to determine risk

factors and role of intrapartum asphyxia causing adverse neonatal outcomes in infants delivered at term.²

The aim of foetal surveillance is to identify foetuses at risk for neonatal and long-term injury due to asphyxia and to prevent morbidity and mortality. Routine tools of intrapartum foetal surveillance are intermittent foetal heart auscultation, observation for MSAF, cardiotocography and foetal scalp blood sampling.³

Cardiotocography monitoring is a modern and non-invasive method for assessing both antepartum and intrapartum fetal status, this method having a clear impact on obstetrical care. The original purpose of continuous electronic foetal heart monitoring during labour to monitor the foetus to prevent intrapartum still birth and perinatal morbidity.⁴

Intrapartum monitoring tool with high accuracy is required to ensure foetal well-being in labour. Intermittent auscultation of FHR and electronic foetal monitoring such as cardiotocography are most popular methods for intrapartum foetal surveillance, whereas the former focuses only on estimation of basal heart rate, the latter also reflects upon other qualities of foetal heart rate such as variability, accelerations and decelerations.⁵

Electronic foetal monitoring has become a routine in many labour wards. Despite its popularity CTG has not proved to be ideal monitoring tool. Though a normal trace is predictive of normal acid base status at birth, in about 98% cases an abnormal trace has a low positive predictive value in terms of fetal pH <7.25.⁶

After birth foetal asphyxia is subjectively assessed by APGAR score and objectively by cord blood pH and Lactate levels. Studies on umbilical cord blood for determination of lactate indicate that high levels seem to be correlated to foetal metabolism for anaerobic glycolysis taking place in oxygen deprived tissues of foetus. Measuring umbilical artery pH and lactate is regarded as an efficient and accurate technique for diagnosis of foetal distress.⁷

Acute foetal distress induces asphyxia leading to hypoxia of most of the organs which causes increase in lactic acid level along with alteration in pH and HCO₃. Most of the parameters used for foetal monitoring have good sensitivity but low specificity.⁸

Umbilical cord blood acid base analysis has emerged in recent years as a method of assessing new born objectively because other predictors of outcome including APGAR score are based on subjective criteria and they correlate poorly with neonatal outcome.⁹

In order to better define the metabolic status of the newborn, umbilical lactate levels have been measured. Lactate is converted from pyruvate during anaerobic metabolism and it is well acknowledged that blood lactate is useful

systemic indicator of circulatory impairment and anaerobiosis.¹⁰

Exact incidence of foetal distress is uncertain, but estimates range from one in every 25 births to one in every 100 births.¹¹ Electronic foetal monitoring is used routinely to know the condition of the baby during intrapartum period. Normal trace correlates highly with absence of acidemia at birth. Abnormal trace needs further evaluation. Hence this study is undertaken to know the validity of cardiotocography and its correlation with umbilical cord arterial blood gas analysis and cord blood lactate levels. The change in the cord blood pH and lactate is related to the degree and relation of foetal stress and foetal buffering capacity.

Hence this study allows comparison of cardiotocographic abnormalities and umbilical cord arterial blood gas analysis and cord blood lactate level in detecting metabolic status of the baby after birth.

METHODS

An Observational study was conducted on 295 pregnant women in labour with abnormal CTG registered in the Obstetrics and Gynaecology Department in Bangalore Baptist Hospital.

All pregnant women meeting the inclusion criteria and consenting for study were recruited.

Inclusion criteria

All term (> 37 weeks) singleton pregnancies with vertex presentation in labour with foetal distress.

Exclusion criteria

- All high-risk pregnancies (anaemia, hypertension, thyroid disorders, diabetes, epilepsy, asthma, teenage, elderly)
- Intrauterine growth restriction, oligohydromnios, preterm deliveries.
- Previous caesarean section
- Elective caesarean section
- Multiple gestation, malpresentations
- Abruption placenta
- Foetus with congenital anomalies
- Maternal infections and PROM

Study period was of 12 months (July 2014 to July 2015)

Methodology

The study was explained to the pregnant women during her antenatal check-up. At the time of labour, CTG was done for all. After delivery of the baby, umbilical cord arterial blood was collected for lactate and cord blood pH with

abnormal CTG. The baby was observed for 24 hours and assessed for wellbeing and adverse outcomes.

After taking informed consent from women meeting inclusion criteria, Cardiotocography was done during intrapartum period, 2 blood samples were collected immediately after delivery by double clamping the cord in babies with abnormal CTG.

Umbilical cord arterial blood was drawn from isolated segment into heparinised syringe for arterial blood gas analysis. Two ml of umbilical cord arterial blood was drawn into sodium fluoride potassium oxalate tube. Sent for estimation of lactate and umbilical cord arterial blood gas analysis. Umbilical cord arterial blood gas analysis and cord blood lactate levels were tested and compared with adverse early neonatal outcome like low Apgar scores, NICU admissions, assisted ventilation like bag and mask, intubation, IPPR, events in first 24 hours of birth.

The following ranges of umbilical cord lactate values and pH were taken as abnormal for the study:

Umbilical artery pH¹

- <7.15: Acidemia
- <7: Severe acidemia

Cord blood lactate²⁹

- >5 mmol/l: acidemia
- >10 mmol/l: Severe acidemia

In order to comment which test is better, ROC curve was constructed using sensitivity and specificity for different parameters. The accuracy of the test depends on how well the test separates the group being tested into those with and without the disease in question. Accuracy is measured by the area under the ROC curve.

An area of 1 represents a perfect test; an area of .5 represents a worthless test. A rough guide for classifying the accuracy of a diagnostic test is the traditional academic point system:

- 0.90-1 = excellent (A)
- 0.80-0.90 = good (B)
- 0.70-0.80 = fair (C)
- 0.60-0.70 = poor (D)
- 0.50-0.60 = fail (F)

Statistical package for social services (SPSS) was used for analysis.

RESULTS

The area under ROC is showing serum lactate is more accurate in predicting adverse perinatal outcome compared to umbilical artery pH.

The sensitivity and specificity for lactate and pH in relation NICU stay, Resuscitation, low Apgar scores at 1 min, 5 min and outcome are represented as receiver-operator curves.

ROC for resuscitation

Out of 295 babies with abnormal CTG,32 babies showed severe metabolic acidosis (serum lactate >10 mmol/l). Out of 32 babies with severe metabolic acidosis,24 babies required resuscitation.

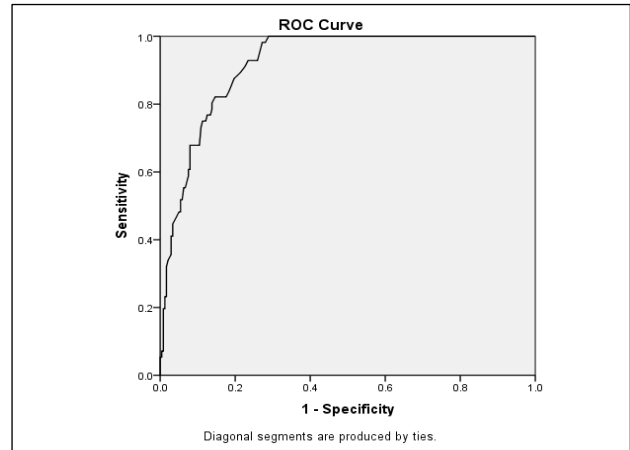


Figure 1: Serum lactate.

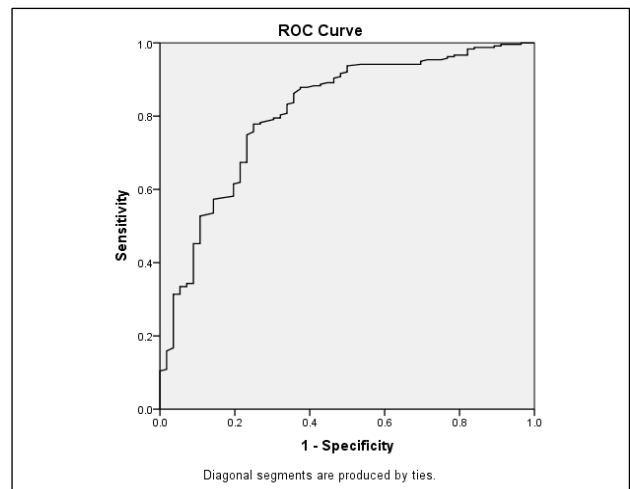


Figure 2: Cord arterial pH.

Figure 1 and 2 shows ROC curve for cord blood lactate and cord arterial pH for babies required resuscitation. Area under curve for cord blood lactate is 0.920 (indicates test is excellent) and for cord arterial pH is 0.811(indicates the test is good),so cord blood lactate is better test compared to cord arterial pH.

ROC for APGAR at 1 min

Out of 32 babies with severe metabolic acidosis,28 babies had apgar score ≤7 at 1 min.

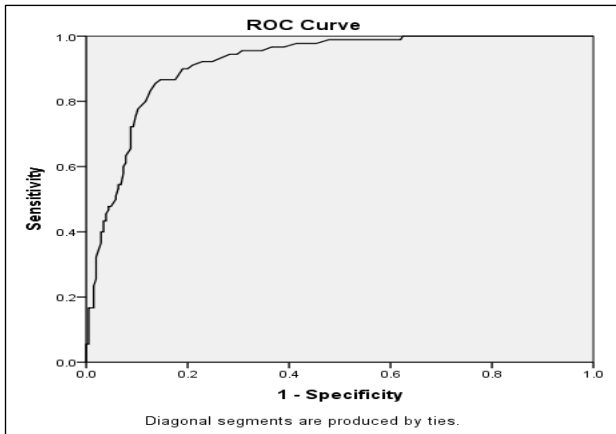


Figure 3: Serum lactate.

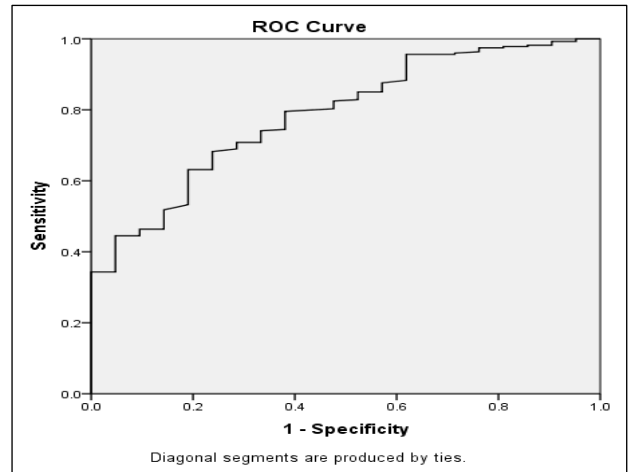


Figure 6: Cord arterial pH.

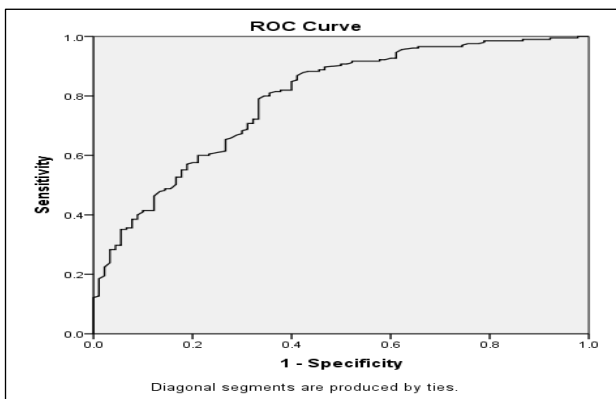


Figure 4: Cord arterial pH.

Figure 5 and 6 shows ROC for cord blood lactate and cord arterial pH for babies with Apgar less than 7 at 5 minutes. Area under ROC curve for cord blood lactate is 0.873 (test is good) compared to cord pH which is 0.786 (test is fair), so cord blood lactate is a better test compared to cord arterial pH.

Figure 3 and 4 shows ROC for cord blood lactate and cord arterial pH for the babies with Apgar less than 7 at 1 minute. Area under ROC curve for cord blood lactate is 0.917 (test is excellent) compared to cord pH which is 0.789 (test is fair), so cord blood lactate is an excellent test compared to cord arterial pH.

ROC for APGAR at 5 minutes

Out of 32 babies with severe metabolic acidosis, 22 babies had Apgar ≤ 7 at 5 minutes.

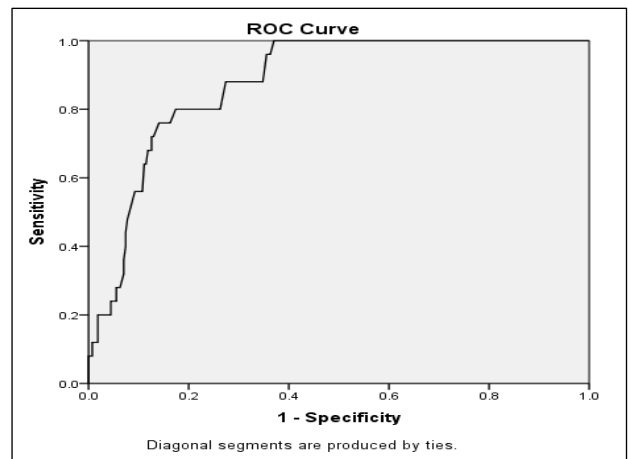


Figure 7: Cord blood lactate.

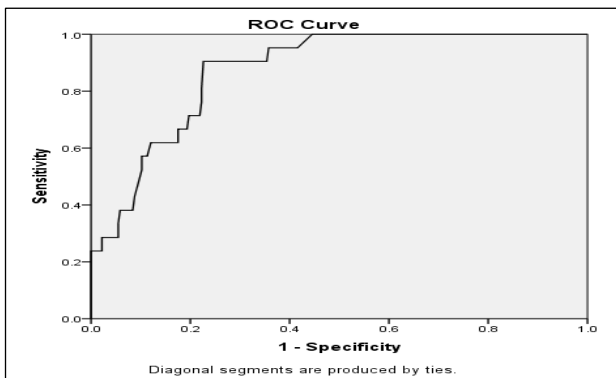


Figure 5: Cord blood lactate.

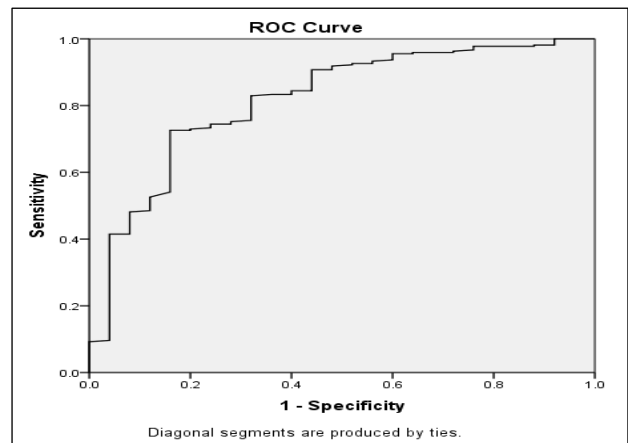


Figure 8: Cord arterial pH.

ROC for NICU admission

Out of 295 babies, 21 babies got shifted to NICU. Figure 7 and 8 shows ROC for serum lactate and cord arterial pH in babies shifted to NICU. Area under ROC curve for cord blood lactate is 0.878 (test is good) compared to cord pH 0.817 which is (test is good), so cord blood lactate and cord arterial pH both are good in predicting NICU Admission.

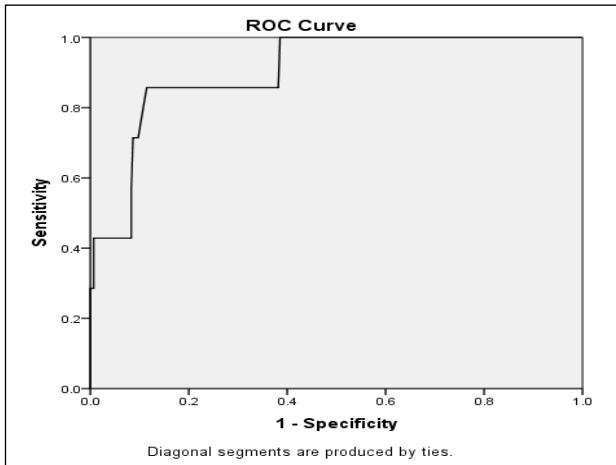


Figure 9: Serum lactate.

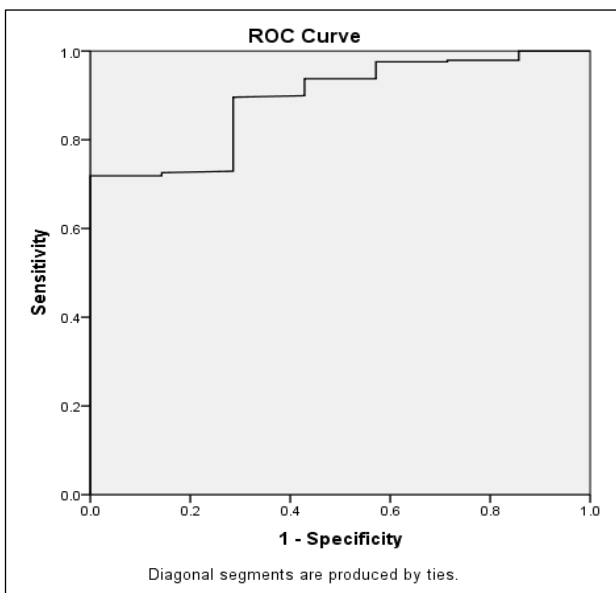


Figure 10: Cord arterial pH.

ROC for Bad outcome

Out of 295 babies, 7 babies had seizures within 24 hours of birth. Out of 7 babies, 5 babies had serum lactate > 10 mmol/l.

Figure 9 and 10 shows cord blood lactate and cord arterial Ph in babies with bad obstetric outcome. Area under ROC curve for cord blood lactate is 0.905 (test is excellent) compared to cord pH which is 0.891 (test is good), so cord

blood lactate is an excellent test compared to cord arterial pH in predicting adverse neonatal outcome.

DISCUSSION

This is an observational study in which 295 pregnant women in labour with abnormal CTG suspected to have intrapartum foetal distress were recruited. The study was done between June 2014 to June 2015 in Bangalore Baptist Hospital, Bangalore.

After taking informed consent from term pregnancies with abnormal CTG, umbilical cord blood was collected and sent for estimation of serum lactate and cord pH and both were used for prediction of adverse neonatal outcome and compared.

The babies with both normal and abnormal serum lactate groups were found to be comparable with respect to maternal age, parity, birth weight and sex of the baby etc., thereby eliminating majority of the confounding factors.

Out of 295 babies with abnormal CTG, 32 babies showed severe metabolic acidosis (serum lactate >10 mmol/l). Out of 32 babies with severe metabolic acidosis, 28 babies had apgar score ≤7 at 1 minute, 22 babies had Apgar ≤7 at 5 minutes, 24 babies required resuscitation, 21 babies got shifted to NICU and 5 babies showed seizures within 24 hours of birth.

In the present study babies with Apgar score ≤7 at 1 minute, 87.5% of the babies showed elevated cord blood lactate and Apgar score ≤7 at 5 minutes only 68.7% of babies showed elevated cord blood lactate. Specificity of serum lactate (97.7%) and umbilical artery pH (95.97%) was almost similar in babies with Apgar score of ≤7 at 1 min, but sensitivity of serum lactate (23.14%) and cord pH (31.4%) is less in babies with Apgar score ≤7 at 1 minute.

Present study was almost similar to study conducted by Damodaran G et al in her study on APGAR score and umbilical cord blood levels of lactate and Creatinine in perinatal asphyxia concluded that cord blood lactate assay of new born will help to evaluate the severity of anoxia and it will be useful to nullify any subjective errors produced during the clinical assessment of newborn babies by Apgar score. In the present study serum lactate being an objective parameter predicted neonatal outcome more accurately compared to Apgar score, which is a subjective parameter.¹³

In the present study area under ROC showed serum lactate is more accurate in predicting adverse neonatal outcome (Area under ROC for serum lactate was between 0.8-0.9) compared to umbilical artery pH (area under ROC for umbilical artery pH was between 0.7-0.8). In the present study we have taken 95th percentile as cut off value for serum lactate (i.e 10 mmol/l). If we take 95th percentile (10 mmol/l) as cut off value, specificity of serum lactate increases compared to cord arterial pH in predicting

adverse neonatal outcome like low Apgar score, resuscitation, NICU admission and hypoxic events in first 24 hours of delivery.

Compared to study done by Gjerris AC et al in his descriptive study of umbilical cord arterial blood samples from 2554 singleton deliveries, ROC curves suggested a lactate cut-off level of 8 mmol/l for indicating intrapartum asphyxia.¹⁴ In the present study ROC curves suggested that lactate cut off level of 10 mmol/l for indicating intrapartum asphyxia.

Out of 295 babies 7 babies had seizures within 24 hours of birth. Out of 7 babies, 5 babies had serum lactate >10 mmol/l indicating serum lactate is better predictor of hypoxic episodes in first 24 hours of birth. Present study correlated with study done by Shah S et al. But in the present study, we have taken only one measurement of lactate not serial measurements in predicting early neonatal outcome.

Shah S et al in his study on postnatal lactate as an early predictor of short-term outcome after intrapartum asphyxia, concluded that the highest recorded lactate level in the first hour of life and serial measurements of lactate are important predictors of moderate-to-severe HIE.¹⁵

In the present study specificity of cord blood lactate in terms of predicting adverse perinatal outcome like NICU admission, assisted ventilation and neurological abnormality is almost similar to study conducted by Magnus et al who concluded that, umbilical artery lactate concentration and acid-base balance predicted perinatal outcomes with similar efficacies.

Specificity of cord arterial pH is almost similar in predicting adverse perinatal outcome compared to study conducted by Magnus et al.¹⁶

In the present study sensitivity and specificity of serum lactate (if we take cut off value of >5 mmol/l) is almost similar to cord arterial pH in predicting adverse neonatal outcome like low Apgar score, resuscitation, NICU admission and hypoxic episodes in first 24 hours of birth.

Comparison with other studies

Magnus et al in his prospective study of 4045 cord samples, lactate was measured. The umbilical artery lactate concentrations were significantly elevated in instrumental deliveries (2.65 - 1.2 mmol/L) and in emergency cesarean sections (2.44±1.7 mmol/L) compared with spontaneous vaginal delivery (1.87±0.94 mmol/L) (/a <0.001, p <0.001). Lactate was comparable to pH and base deficit in sensitivity, specificity, and positive and negative predictive values in relation to morbidity and mortality. Umbilical artery lactate concentration and acid-base balance predicted perinatal outcomes with similar efficacies. In our study also cord blood lactate and pH have

shown similar efficacies in predicting adverse perinatal outcome.¹⁶

Wing FW et al showed that definite correlation exists between the lactate level and pH / base deficit in both the umbilical artery and vein in normal babies as well as those with foetal distress. As lactate is simpler and cheaper to measure, it is a promising parameter that may be used in place of pH or base deficit in assessing the metabolic status of newborn.¹⁷

Limitations of this study were

- Small sample size, larger studies required.
- In the present study we have taken pregnant women with abnormal CTG and there is no comparison with normal CTG and its correlation with serum lactate and cord pH in predicting adverse neonatal outcome.
- Lactate and umbilical artery pH measured on cord blood sample immediately after delivery, we did not get serial measurement of lactate and pH corresponding to 1 minute and 5 minutes APGAR in predicting adverse perinatal outcome.

CONCLUSION

Following conclusions were drawn from our study

- Umbilical cord blood lactate is more specific than umbilical artery pH in predicting adverse neonatal outcome, since it represents the metabolic part of the acid-base balance.
- Area under ROC (at 95th percentile) have shown serum lactate is more accurate in predicting adverse neonatal outcome compared to umbilical artery pH at birth.

Recommendations

We recommend measurement of umbilical cord arterial lactate immediately after delivery in babies with intrapartum fetal distress.

It helps:

- To identify babies with intrapartum fetal distress and early intervention to prevent early adverse neonatal outcome
- It also helps to supplement APGAR scores.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Tasnim N, Mahmud G, Akram S. Predictive accuracy of intrapartum Cardiotocography in terms of fetal acid

- base status at birth. *J Coll Physicians Surg Pak.* 2009;19(10):632-5.
2. Malin GL, Morris RK, Kha KS. Strength of association between umbilical cord pH and perinatal and long-term outcomes: systematic review and meta-analysis. *BMJ.* 2010;340:c1471.
 3. Parveen S. Umbilical cord arterial blood base excess as gold standard for foetal well-being screening test validity at term delivery. *J PakMed Assoc.* 2010;60(5):347-50.
 4. Palomäki O, Luukkaala T, Luoto R, Tuimala R. Intrapartum cardiotocography: the dilemma of interpretational variation. *J Perinat Med.* 2006;34(4):298-302.
 5. Mires G, Williams F, Howie P. Randomized controlled trial of cardiotocography versus Doppler auscultation of fetal heart at admission in labour in low risk Obstetric population. *BMJ.* 2001;322(7300):1457-60.
 6. Dellinger EH, Boehm FH, Crane MM. Electronic fetal heart rate monitoring: early neonatal outcomes associated with normal rate, fetal stress and fetal distress. *Am J Obstet Gynecol.* 2000;182(1)(1):214-20.
 7. Borruto F, Comparetto C, Wegher E, Treisser A. Screening of foetal distress by assessment of umbilical cord lactate. *Clin Exp Obstet Gynecol.* 2006;33(4):219-22.
 8. Johnson JW, Richards DS, Wagaman RA. The case for routine umbilical blood acid-base studies at delivery. *Am J Obstet Gynecol.* 1990;162(3):621-5.
 9. Modarressnejad V. Umbilical cord blood pH and risk factors for acidaemia in Neonates in Kerman. *East Mediterr Health J.* 2005;11(1-2):96-101.
 10. Sykes GS, Molloy PM, Johnson P, GuW, AshworthF, Stirrat GM, et al. Do Apgar scores indicate asphyxia? *Lancet.* 1982;1(8270):494-6.
 11. What to Expect. Fetal distress during pregnancy. Available at <http://www.whattoexpect.com/pregnancy/pregnancy-health/complications/fetal-distress.aspx>
 12. Hamed HO. Intrapartum fetal asphyxia: study of umbilical cord blood lactate in relation to fetal heart rate patterns. *Arch Gynecol Obstet.* 2013;287(6):1067-73.
 13. Damodaran GK. APGAR score and umbilical cord blood levels of lactate and creatinine in perinatal asphyxia. *Int J Biomed Res.* 2015;6(04):242-5.
 14. Gjerris AC, Staer-Jensen J, Jørgensen JS, Bergholt T, Nickelsen C. Umbilical cord blood lactate: a valuable tool in the assessment of fetal metabolic acidosis. *Eu J Obstet Gynecol Reprod Biol.* 2008;129(1):16-20.
 15. Shah S, Tracy M, Smyth J. Postnatal lactate as an early predictor of short-term outcome after intrapartum asphyxia. *J Perinatol.* 2004;24(1):16-20.
 16. Westgren M, Divon M, Horal M. Routine measurements of umbilical artery lactate levels in the prediction of perinatal outcome. *Am J Obstet Gynecol.* 1995;173(5):1416-22.
 17. Wing FW, Kok HT, George SH. Umbilical cord lactate: a preliminary study of 130 term babies. *Singapore J Obstet Gynaecol.* 2002;33(2):42-8.

Cite this article as: Patil SS, Sukanya, Rath S, George CE. Study on umbilical cord arterial blood gas analysis and cord blood lactate levels as predictors for adverse neonatal outcome: an observational study. *Int J Reprod Contracept Obstet Gynecol* 2018;7:1494-500.