Routine measurements of cord arterial blood lactate levels in infants delivering at term and prediction of neonatal outcome

Revathy Natesan Subramaniam, FMAS

MAHSA University College Kuala Lumpur, Kuala Lumpur, Malaysia

SUMMARY

Objective: Our purpose was to evaluate the relationship between umbilical cord arterial blood lactate levels with acid base balance to the mode of delivery and short-term neonatal outcome in a large multiracial population delivering at term in University of Malaya Medical Centre.

Materials and methods: Two thousand two hundred and twelve patients of more than 37 weeks of gestation with singleton, liveborn infants with no major anomalies delivering between January 2013 to December 2013 were analysed. Lactate was measured by using portable Lactate analyzer that requires 5 µml of blood and provides the result within 1 minute. The deliveries took place at the Department of Obstetrics and Gynaecology, University Malaya Medical Centre, Malaysia where umbilical cord blood sampling and blood gas analysis is a part of the routine assessment of all newborn.

Results: Gestational age ranged from 37 to 43 weeks (mean 39.05 weeks). The highest mean arterial cord lactate values were noted among babies delivered instrumentally (4.87 mmol/L). Infants who had a normal vaginal delivery had the second highest levels (3.36 mmol/L), followed by infants delivered by emergency caesarean section (3.30mmol/L). The lowest lactate values were noted in deliveries by elective caesarean section (3.0mmol/L). Cord arterial lactate levels were significantly higher among infants born with low Apgar scores (7.02 mmol/L vs 4.6mmol/L, $P < 0.001$). High arterial cord lactate was a significant predictor of admission to Neonatal intensive care unit (NICU) was 6.0mmol/L. Receiver operator curve (ROC) analysis suggests that lactate and pH are virtually equivalent in their correlation with adverse neonatal outcome.

Conclusion: Cord lactate levels are significantly related to the mode of delivery and is equivalent to cord arterial pH in predicting adverse neonatal outcomes, with similar efficacies; however, its simplicity, less sampling failure and low cost makes lactate analysis an interesting alternative in obstetric care.

KEY WORDS:
Lactate, fetal asphyxia, fetal distress, cord pH, Base excess

INTRODUCTION

Birth asphyxia has long been considered a major cause of perinatal death and neurological injury. During anaerobic metabolism, lactate production is predominant and is a major component of metabolic acidosis. Evaluation of the state of the newborn has usually been based on Apgar scores and blood gas parameters of umbilical cord blood. After the classic work of Myers et al describing accumulation of lactic acid in the brain in association with hypoxia, lactate concentration in thefoetal blood has   gained increased attention in peri- natal medicine.[1,2] Studies by Nordstrom [10] have shown that fetus is the main contributor to the fetal lactate increase during labour and not significantly influenced by maternal or by the uteroplacental lactate production. Some authors [11] found no significant correlation between umbilical cord blood lactate and SBE or pH, whereas others[12,13,14] found a positive, though not strong, correlation. Lactate concentration in umbilical cord blood at delivery might be a more precise tool in the assessment of fetal metabolic acidosis during labour.

Recently an electrochemical method has been developed that enables us to measure lactate on 5µl of blood in 1 minute. The simplicity of the method makes it more applicable and umbilical cord blood lactate analysis and cord pH have been shown to be comparable in predicting perinatal outcome. A significant practical advantage is that lactate requires less blood, the technique is faster and less likely to be unsuccessful.

MATERIAL AND METHODS

University Malaya Medical Centre, Malaysia serves a Multiracial population with tertiary care facility. This study has been approved the Medical Ethics Committee of university Malaya and a research grant was provided (Ref.No 137/09).

The hospital database was used to obtain the following variables for this study population: maternal medical problems, pregnancy complications, obstetric history, newborn cord gases, pH, Apgar score at 5 minutes, need for neonatal intensive care unit (NICU) admission, and selected neonatal outcomes, including the presence or absence of respiratory distress syndrome, need for assisted ventilation, intraventricular hemorrhage (IVH), and demise. The study

Table I: Descriptive Data on the Study Population

	Total	Percentage
No of births	2212	
Spontaneous vaginal delivery	1631	73.7%
LSCS	517	23.4%
Emergency LSCS	372	19.2%
Elective LSCS	175	4.2%
Instrumental delivery	65	2.9%
Neonatal outcome		
APGAR < 7 at 1min	19	1.4%
APGAR < 7 at 5min	12	
NICU Admission	19	0.85%
ABG		
pH <7.2	311	14%
ABE < -12	21	0.9%
Cord blood lactate >4.5mmol/l	405	18%
Neonates with Cerebral palsy	Nil	Nil

population was formed on the basis of the following inclusion criteria: date of birth between January 1,2013 to December 31st , 2013; singleton; liveborn; gestational age at birth 37 weeks or greater with no major anomalies .

Umbilical cord blood is routinely sampled by nursing personnel immediately after delivery for all infants deemed to be viable. Subsequent analysis is usually achieved within 30 minutes of delivery. Arterial umbilical blood samples were drawn from a double-clamped segment of the umbilical cord into 2-ml plastic syringes flushed with a heparin solution, and the acid-base balance was determined with an automized blood gas analyzer (ABL   510, Radiometer, Copenhagen).

The lactate concentration was measured with a single-use strip method and the lactate concentration was obtained within 60 seconds after a blood sample and were performed by midwives and obstetric nurses within 2 minutes of birth. All statistical analyses were carried out using SPSS for Windows software . Receiver-operator curves were used to determine cut off values for lactate and to compare lactate with pH and base deficit .

RESULTS

Two thousand two hundred and twelve patients with singleton, liveborn infants with no major anomalies delivering between January 2013 to December 2013 were analysed. Gestational age ranged from 37 to 43 weeks (mean 39.05 weeks). The lactate concentration was significantly higher in vaginal deliveries relative to elective cesarean section. The highest mean arterial cord lactate values were noted among babies delivered instrumentally (4.87 mmol/L). Infants who had a normal vaginal delivery had the second highest levels (3.36 mmol/L), followed by infants delivered by emergency caesarean section (3.30mmol/L). The lowest lactate values were noted in deliveries by elective caesarean section (3.0 mmol/L). The highest concentration was found among patients delivered by vacuum extraction for fetal distress. Similar trends were noted for cord arterial pH values.

Cord arterial lactate levels were significantly higher among infants born with low Apgar scores (6.56mmol/L vs

3.3mmol/L, P < 0.001). Multiple regression analysis with lactate concentration as the dependent variable and pH, base deficit, as independent variables revealed that lactate correlated significantly with pH($R^2 = 0.20$, p < 0.001), base deficit ($R^2 = 0.29$, p < 0.001). There were 19 admissions to neonatal intensive care units. The reasons for admission were often, infant respiratory difficulties requiring observation and supportive care. There were no neonatal deaths . Receiver-operator curve analysis suggests that both arterial pH and lactate are very similar in predicting adverse neonatal outcomes. ROC-curves suggested a lactate cut-off level of 6 mmol/l for indicating intrapartum asphyxia comparing with base deficit of less than -12 mmol/l.

DISCUSSION

Intrapartum asphyxia is estimated to be accountable for 7–15% of neonatal mortality and severe morbidity. The Apgar score was devised in 1952 by Virginia Apgar as a simple and repeatable method to quickly and summarily assess the health of newborn children. However, it gives no information of acidosis/hypoxia and has a very low predictive value in identifying long-term morbidity.

Respiratory acidosis is a result of accumulating carbon dioxide usually caused by compression of the umbilical cord, decreased fetal cardiac output or insufficient placental perfusion. Metabolic acidosis develops in the late stage of fetal hypoxia when oxygen supply to the fetus becomes insufficient and the metabolism of carbohydrates is converted into anaerobic metabolism with the production of lactic acid. When the concentration of lactate rises, actual base excess (ABE) levels decrease. The levels of ABE are the results of the lactate concentration. Therefore, lactate would seem the most direct parameter expressing the severity of metabolic acidosis. Moreover, lactate has the obvious advantage of being directly measurable, whereas base excess is calculated.

More recently, significant or pathologic fetal acidemia has been redefined as an umbilical artery pH less than 7.00 [3,4] with the metabolic component of the acidemia thought to be more closely associated with neonatal morbidity and death.[5,6,7,8] However there is no international consensus about a lower pH threshold with definitions of acidosis during labour ranging from a pH of 7.00 to 7.20. However, lactate and acid-base balance had similar predictive properties, but the simplicity and low cost makes lactate an interesting alternative to the conventional acid- base analysis in obstetric care.

In this study the highest mean arterial cord lactate values were noted among babies delivered instrumentally (4.87 mmol/L (4.87 mmol/L). Infants who had a normal vaginal delivery had the second highest levels (3.36 mmol/L), followed by infants delivered by emergency caesarean section (3.30mmol/L). The lowest lactate values were noted in deliveries by elective caesarean section (3.0 mmol/L. The strong correlation found between lactate and pH revealed that lactate correlated significantly with pH ($R^2 = 0.20$, p < 0.001), base deficit ($R^2 = 0.29$, p < 0.001) is highly significant. This strong correlation suggests that the lactate value could be used as a supplement to or instead of pH. Our

optimal cut-off point for cord arterial lactate of 6 mmol/l . It is however significantly lower than the cut-off of 8.0 mmol/l suggested by Gjerris and colleagues[9]; in their study.

Our results suggest that cord arterial pH and lactate are equivalent in their correlation with poor neonatal outcome at term, and that the mode of delivery has significant impact on their levels. However estimation of lactate is simpler and has less sampling failure and its low cost makes it a better choice compared to indirect measures of umbilical cord blood gases and pH.

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