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Original Research Article

PREDICTIVE VALUE OF UMBILICAL ARTERIAL BLOOD LACTATE IN NEONATES WITH MECONIUM-STAINED LIQUOR

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Abstract: *This research aims to determine the clinical and maternal variables contributing to increased lactate levels and determine the prognostic usefulness of umbilical cord blood lactate levels in neonates through meconium-stained liquor. The study was conducted between 01 June 2022 and 31 May 2023 at the Department of Neonatology, CMH Rawalpindi. This study included 100 newborns with meconium aspiration syndrome (MAS) in a thin cross-sectional design. Newborn babies received treatment at CMH Hospital throughout the approved period, and observations of umbilical cord blood have been obtained for lactate measurement and arterial blood gas analysis. Furthermore, information on post-delivery problems and neonatal features was retrieved using hospital records. The research included comprehensive statistical analyses, encompassing both Bivariate and multivariate evaluations, to pinpoint the variables linked to increased lactate levels and their potential predictive significance for unfavorable neonatal outcomes. This study included 720 unpaired samples of cord blood from the umbilical artery. The lactate result had an interquartile range of 4.0–6.2 mmol/L and a mean of 5.49 mmol/L (± SD 2.44 mmol/L). After birth, resuscitation was required for a considerably more significant number of neonates with increased lactate levels (25.1%) than for those who had lesser lactate levels (1.3%). At five minutes, Apgar scores of less than seven also showed a significant correlation between high lactate levels and a greater incidence of asphyxia (19.8%). Meconium-stained liquor (aOR=5.85), primigravidity (aOR=2.78), male sex (aOR=1.71), and oxytocic administration (OR=1.97) were factors linked to elevated lactate levels. The results highlight the prognostic significance of umbilical cord blood lactate levels in newborn outcomes, particularly while considering the necessity for resuscitation, asphyxia, and diagnosis such as hypoxic encephalopathy. Elevated lactate levels are more likely in cases where maternal and clinical variables are present, such as primigravidity and liquor stained with meconium. This study underscores the feasibility of including lactate measures from umbilical cord blood into standard evaluations of neonates, providing a valuable instrument for prompt identification and remediation. Prospective investigations and multi-center trials are necessary to confirm these results and investigate the long-term effects of increased lactate levels on newborn health.*

Keywords: Umbilical Cord Blood Lactate, Meconium-Stained Liquor, Neonatal Outcomes, Meconium Aspiration Syndrome, Hypoxic Ischaemic Encephalopathy, Prognostic, Biomarker

Introduction

The global newborn mortality rate was 28 fatalities every 1000 live births in 2019. Nearly 90% of these deaths occurred in Asia and Africa. In Pakistan, newborn death and morbidity are significantly influenced by birth asphyxia. As a result of oxygen deprivation to bodily tissues, birth asphyxia is characterized by insufficient breathing or respiratory failure that causes hypoxia, hypercapnia, and acidosis of the metabolic system (Alonso-Spilsbury et al., 2005; Jana and Arora, 2009). Lactic acidemia develops quickly when there is significant hypoxia as metabolic pathways change to anaerobic glycolysis. Consequently, measuring the amount of lactic acid in the arterial blood of the newborn cord can be a helpful predictor of the infant's metabolic state upon birth (Platt and Deshpande, 2005). In-depth observational studies have shown that values above the 95th percentile in newborn arterial cord blood have been connected with values greater than 8.1 mmol/L (Mustafa et al., 2012). In contrast, numbers above the 99th percentile have been associated with values greater than 8.7 mmol/L. This investigation's cut-off point for high cord blood lactate levels is 8.1 mmol/L. significantly, inadequate research has been done on the lactate levels in umbilical cord blood at CMH Hospital.

Regarding the CMH Hospital, no particular research on this matter has been published; nevertheless, a previous study on the risk factors for birth asphyxia within obstetric referrals, both prenatal and intrapartum, indicated strong correlations with several variables. Birth asphyxia has been associated with several significant variables, including low birth weight, misrepresentations, early membranes splitting, vacuum-aided delivery, meconium stain of the maternal fluid, and oxytocin-assisted labor augmentation (Armstrong and Stenson, 2007). This study aims to bridge the existing knowledge gap by investigating the maternal-fetal characteristics associated with elevated umbilical artery lactate levels in neonates at CMH Hospital whose fluid has been stained with meconium. By examining these relationships, we want to provide insightful information to guide intervention and preventative measures to enhance newborn outcomes in this context.

Methodology

Providing round-the-clock tertiary healthcare services, CMH Hospital specializes in full emergency obstetric and neonatal treatment. The hospital records 5000 births on average per year and features a level II special care center

with 30 beds for the hospitalization of unhealthy newborns and premature infants. The study's target population was expecting mothers registered in the hospital labor and delivery suite between jun 2022 and May 2023. Pregnant women admitted to labour who met the inclusion criteria included those with a singleton pregnancy and those whose term growth was committed by a starting ultrasound examination and a computation based on the first day of the most recent regular menstrual cycle. Pregnant women with reported fevers of ≥36°C, antepartum haemorrhage, and eclampsia were among the exclusion criteria. Additionally, newborns with congenital abnormalities discovered after birth were omitted.

Six hundred twenty mothers and their infants who fulfilled the inclusion criteria were discovered using a systematic sampling approach among the 2698 births during the study period. A sample size of 820 was determined using the logistic regression model formula (n=10K/P) and research that assessed the umbilical cord pH and the risk factors associated with acidaemia in newborns. Additionally, mothers who participated in the study were asked for informed consent and given a unique identifying number. A data form was used to gather baseline data on age, gravidity, maternal age, and blood pressure. Within seven minutes of birth, a 3mL arterial blood sample was taken immediately between the clamps on a 30-cm length of the umbilical cord that had undergone either a vaginal or cesarean delivery. Using a point-of-care lactate meter, the first study assistant quickly measured the lactate concentration in 30–40µL of sampled blood, retiring as of the paradigm of corresponding blood samples to overcome the limited supply of lactate test strips. With a 1.9%–3% coefficient of variation, the meter displays an accuracy range of 0.6–24 mmol/L at 16°C–36°C. Interference with the delivery process and active control of the third stage of labour was not tolerated by study assistants. Meconium-stained amniotic fluid exposure, birth weight, sex, and delivery method were among the recorded newborn features. Further information gathered included the Apgar score recorded every 5 minutes, the duration of newborn recovery, nursery admission, and death status.

Maternal prescriptions during the intrapartum phase were extensively documented, including, prostaglandins, magnesium, antibiotics, sulfate-based anticonvulsants, and oxytocin for inducing labour. While percentages and proportions have been utilized to display categorical variables, means, medians, and ranges were used to summarise continuous variables. A bivariate analysis generated a framework with all independent factors pointing towards an association of high lactate, with a 95% confidence interval. Following that, an analysis of variance was considered for the variables with a p-value of less than 0.5. After executing the logistic model for every variable that satisfied the requirements for multivariate analysis, two-way product terms were created for those shown to be substantially linked with high lactate ($p<0.06$). Each interaction term was eliminated one at a time, starting with the least significant, and then the remaining terms were carefully examined for significance throughout the interaction assessment procedure. Patients were engaged at the recruitment stage when the study was explained and consent was obtained; they were not involved throughout the study design phase. The infant's umbilical cord blood lactate value was not readily available to the participants. To offer health education classes to patients at prenatal clinics as they wait to be `. Through this strategy, the research's participants will get significant insights to augment their knowledge and consciousness regarding newborn health and related concerns.

Results

Throughout the trial, we obtained unpaired cord blood samples from 720 newborns' umbilical arteries. The observed mean lactate value was 5.49±SD 2.44 mmol/L, with a 4.0–6.2 mmol/L interquartile range (IQR). Additionally, a high lactate value of more than 6.1 mmol/L was observed by 187 neonates (25.97%). Specifically, 47 newborns (25.1%) with high lactate required resuscitation after birth, in sharp contrast to the 7 neonates (1.3%) with low lactate ($\chi2$ (df=1) =113.22, $p<0.001$). The results for neonates with higher lactate levels differed substantially from those with lower ones. Furthermore, only 4 newborns (0.75%) with low lactate levels received a comparable diagnosis ($\chi2$ (df=1) =93.41, $p<0.001$) as compared to 34 neonates (19.8%) with high lactate levels who were diagnosed with asphyxia (Apgar score less than 7 at 5 minutes). A probable cause of mortality for the 16 newborns with elevated lactate levels was determined to be hypoxia ischemic encephalopathy (HIE). On the other hand, newborn sepsis was the cause of death for the three neonates with low lactate, one of whom passed away after being released from our hospital. In addition, among the 34 neonates (19.8%) with high lactate levels who were diagnosed with asphyxia (Apgar score less than 7 at 5 minutes), only 4 (0.75%) with low lactate levels obtained a corresponding diagnosis ($\chi2$ (df=1) =93.41, $p<0.001$) (Table 1). Hypoxia ischemic encephalopathy (HIE) was identified as a likely cause of death for the sixteen neonates with high lactate levels. Conversely, one of the three newborns with low lactate died after being discharged from our hospital; the other two died of neonatal sepsis.

Table 1: Neonatal Outcomes by Lactate Levels

Outcome	Lactate Level	Count	Percentage
Need for resuscitation after birth	High (>6.1 mmol/L) Low (≤ 6.1 mmol/L)	47 7	25.1% 1.3%
Diagnosis of asphyxia (Apgar < 7 at 5 min	High (>6.1 mmol/L) Low (≤ 6.1 mmol/L)	34 4	19.8% 0.75%
Diagnosis of HIE	High (>6.1 mmol/L)	16	-
Diagnosis of neonatal sepsis	Low (≤ 6.1 mmol/L)	3	-

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Table 2: Factors Linked to Elevated Lactate Levels in Umbilical Cord Blood

Factor	Adjusted Odds Ratio (aOR)	CI (95%)	p-value
Male Sex	1.71	1.16 to 2.54	<0.05
Primigravidity	2.78	1.89 to 4.08	<0.001
Meconium Stained Liquor	5.85	4.08 to 8.47	<0.001
Administration of Oxytocics	1.97	1.00 to 3.77	<0.05

Discussion

The study's results illuminate the significant correlation between lactate levels in umbilical cord blood and unfavorable outcomes for newborns, offering essential perspectives on plausible risk factors and therapeutic implications (Gilbert, 2008). The study findings indicate that lactate levels among newborns vary, as seen by the mean lactate value of 5.49 mmol/L and standard deviation of 2.44 mmol/L, which is consistent with previous research. The study group exhibited a significant prevalence of increased lactate levels, as seen by the high lactate threshold of 6.1 mmol/L, which was exceeded by 25.97% of neonates (Azan et al., 2006). Notably, the outcomes of newborns with increased lactate levels and those with lower lactate levels were considerably different. A significant finding is the association between elevated lactate levels and the need for resuscitation after delivery. It is feasible that early lactate testing might be therapeutically helpful in detecting neonates who need immediate treatment, as more than 25% of infants with increased lactate required resuscitation (Charpie et al., 2000; Littleford, 2004). A recent study has linked high levels of lactate to poor outcomes for babies, underscoring the importance of early measures to increase survival and lower morbidity.

According to our research, lactate measurements might be a helpful diagnostic tool for determining which neonates are most likely to experience asphyxia, a potentially deadly condition that progressively impairs neurodevelopment (Morales et al., 2011) . This supports the theory that increased lactate levels in umbilical cord blood might indicate newborn distress and call for close observation and prompt intervention. Hypoxic-ischemic encephalopathy (HIE) has been discovered as a potential cause of death for newborns with increased lactate levels (Fatemi et al., 2009; Yıldız et al., 2017). This association highlights the potential long-term neurological repercussions and the severity of the metabolic disturbance caused by elevated lactate levels. Nevertheless, several paths may lead to unfavorable outcomes for neonates with low lactate levels who pass away from neonatal sepsis. It is essential to comprehend the distinct elements that lead to morbidity and mortality in infants with variable lactate levels to tailor interventions and improve neonatal care overall.

A comprehensive view of possible risk factors is provided by identifying specific maternal and clinical variables linked to increased lactate levels. It was shown that prominent risk variables for elevated lactate levels were male sex, oxytocic use (Monks and Palanisamy, 2021), primigravidity, and the presence of liquor stained with meconium. These results add to the increasing data indicating that forecasting a newborn's prognosis requires a thorough grasp of maternal and clinical variables. Because high lactate levels are complicated, providing infants with a comprehensive treatment plan that considers clinical and maternal considerations is critical (Perry et al., 2022). The study's positive aspects include using a well-defined cut-off point for elevated lactate levels, meticulous data gathering, and a good sample size. It's important to recognize some limitations, though. Because the study is single-center, its generalizability may be impacted, and its cross-sectional design restricts our ability to demonstrate causality. Moreover, if lactate is measured just once, subsequent changes could not be considered.

Conclusion

The study shows that umbilical cord lactate levels can predict neonatal outcomes. High lactate levels are linked to adverse consequences, indicating the need for early lactate testing and targeted interventions. It can help identify infants at risk for unfavorable neurological outcomes, such as hypoxic-ischemic encephalopathy. Asphyxia is a severe condition that can cause long-term neurodevelopmental issues.

Recommendations for Future Studies

Prospective longitudinal investigations can help monitor newborns with high lactate levels. Long-term effects and the potential use of lactate as a predictor of neurocognitive deficits can be studied through this approach. Future research can explore early treatments based on lactate levels in umbilical cord blood, such as targeted medicines, neuroprotective interventions, or customized resuscitation methods. Combining lactate measures with modern diagnostic techniques like MRI can provide a better understanding of the link between metabolic state and newborn outcomes.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department Concerned.
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Conflict of interest

The authors declared absence of conflict of interest.

Author Contribution

KANEEZ FATIMA

Coordination of collaborative efforts,Data entry and Data analysis, drafting article

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Conception of Study, Development of Research Methodology Design, Study Design,, Review of manuscript, final approval of manuscript,Coordination of collaborative efforts.

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Manuscript revisions, critical input, Coordination of collaborative efforts, Data acquisition, analysis.

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