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# Correlation between Umbilical Cord pH, Apgar Score and Pregnancy Outcome in High-Risk Pregnancy

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***ABSTRACT:***
***Objective:*** *To study the role of pH value of umbilical artery blood in predicting neonatal well-being and its correlation Apgar score in high risk pregnancy.* ***Methods:*** *A total of 107 singleton high risk pregnancies were studied, the pH value of umbilical artery blood was measured immediately after birth. The Apgar score was performed 1 minute and 5 minutes after birth. Other data like gestational age, need for resuscitation and admission to the newborn ward or Neonatal Intensive Care Unit was gathered by a questionnaire. P-value less than 0.05 was considered being significant.* ***Results:*** *pH value of umbilical artery blood was positively correlated to 1 min Apgar scores (r=0.62; p<0.01. According to Wilk's – Lambda, the pH value of umbilical artery blood was predicting significantly the need for resuscitation and admission to the newborn ward or Neonatal Intensive Care Unit* $(\chi^2 = 71.802, p < 0.01)$ *and* $(\chi^2 = 44.910, p < 0.01)$ *respectively.* ***Conclusions:*** *Umbilical pH value correlates with 1st min Apgar score and can predict pregnancy outcomes, and is useful tool in the assessment of neonatal asphyxia.*

***Keywords:*** *Umbilical Cord, Apgar score, pregnancy outcome, neonatal asphyxia.*

## I. INTRODUCTION

All living cells require oxygen and glucose to ensure the continuity of metabolism, which is the primary source of energy. Glucose can be stored and moved when needed, but short supply of oxygen for a few minutes is sufficient to damage the living cell. During embryo life, the fetal supply of oxygen depends on the mother's full respiratory functions, her circulatory system, placenta functions, gas exchange through it, and umbilical fetal circulation. Anything that affects the above levels may cause a decrease in the concentration of oxygen in fetal arterial circulation (hypoxemia), and similarly may cause hypoxia at the tissue level (fetal hypoxia).
Hypoxemia occurs in most fetuses during labor, as it can be an event that the fetus can adapt to in terms of intensity, duration and recurrent nature of the event. All of this can reduce the risk of exacerbation and hypoxia. When hypoxia occurs, cellular energy products can rely on anaerobic metabolism for a limited period of time, but this method produces less energy 19 times and leads to an accumulation of lactic acid inside the cell, as well as its release into extracellular fluid and embryonic circulation. The increasing concentration of hydrogen ions from intracellular origin in embryonic circulation is called metabolic academia; however it is associated with the increase of hydrogen ions within the cell due to metabolic acidosis. Both terms can be considered synonymous.

The intracellular oxygen concentration levels cannot be measured quantitatively, since fetal hypoxia can only be investigated by documenting metabolic acidosis. Metabolic acidosis can be assessed by immediate umbilical blood sampling, pH, PCO2, HCO3 and BD and BDecf, as calculated from umbilical cord blood using the Siggaard-Andersen formula [1, 2]. Metabolic acidosis is defined as the presence of the following values through secret arterial blood analysis, pH less than 7.2, baseline deficit exceed 12 mmol / L. and several studies indicating a correlation between short-term negative pregnancy

outcomes and laboratory values. Alternatively, it is also possible to use the lactate concentration in the secret arterial blood to estimate metabolic acidosis, and values above 10 mmol / L are strongly associated with short-term negative pregnancy outcomes [3]. Taking into account that the laboratory devices often differ in the method of measurement and calibration and therefore must be taken reference values according to the device itself [4].

The Apgar score reflects the respiratory, cardiovascular and neurological functions of newborns, and decreases when these organs are exposed to severe and prolonged hypoxia. Apgar score in the first minute is an important indicator to start resuscitating a newborn [5], but its association is poor with hypoxia/acidosis events in the uterus. The low Apgar score in both the first and fifth minutes is expected when severe hypoxemia/acidosis occurs in the uterus, but Apgar score in the fifth minute has a strong association with short- and long-term neurological outcomes as well as neonatal mortality [6, 7]. Moreover, it is important to remember that Apgar score is not affected by small degrees of hypoxia, and that it may be differ though assessment among practitioners [8]. Apgar score may be low due to non-hypoxic causes such as prematurity, obstetric trauma, infections, meconium staining and the effect of anesthesia [9]. The present study was carried out to determine the correlation between umbilical cord pH and Apgar score in high-risk pregnant mother.

## II. MATERIAL AND METHODS

This was a prospective cross sectional study conducted in Obstetrics and Gynecology University Hospital of Aleppo during January 2017 to December 2018. Study population consisted of mothers who have admitted in high risk pregnancy ward in OBGYN University Hospital of Aleppo, and are in 32 weeks of gestational age or more; all mothers had cesarean section (C/S) deliveries. All mothers who delivered a baby with a major congenital anomaly or had intra uterine fetal death (IUFD) were excluded from the study.

Immediately after delivery, umbilical cords were clamped on both ends and an arterial blood sample was collected anaerobically in a pre-heparinized insulin syringe. PH, base excess, carbon dioxide pressure (PCO2), PO2 and HCO3 were measured. Apgar score was assessed by a trained physician at 1st and 5thminute after birth. Advanced resuscitation means that a baby required positive pressure ventilation, chest compression and/or drugs administration. All resuscitated babies were transferred to neonatal intensive care unit or newborn services for post resuscitation care. Fetal h was defined by an umbilical cord pH<7.2.

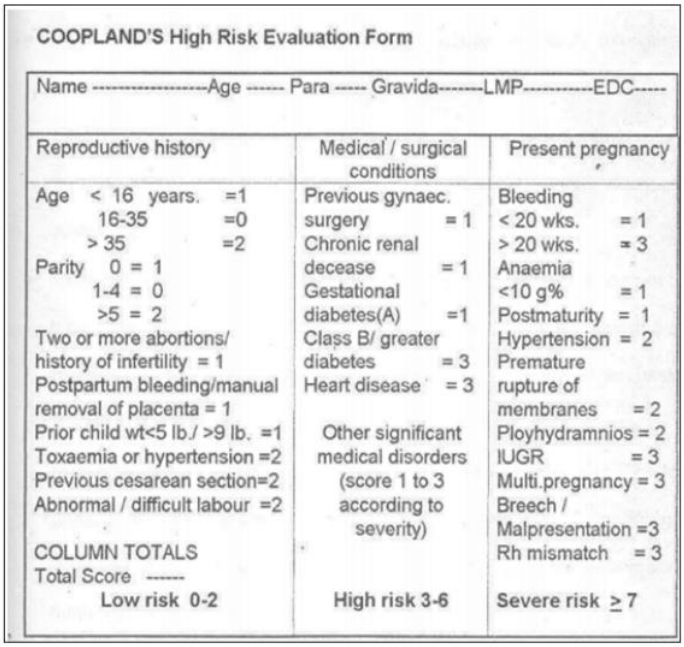
Demographic data like gestational age, birth weight, Apgar score, need for resuscitation and/or newborn ward admissions were collected by a questionnaire. Sample size calculated 107 mother-fetal pair for the group. Analysis was performed by IBM® SPSS® Statistics 25. Multivariate Analysis of Variance, Discriminant Analysis, and Wilk's – Lambda test were used for analysis P<0.05 was considered statistically significant.

## III. RESULTS AND DISCUSSION

In the current study, high risk pregnancies were classified into 3 categories, based on Prenatal High Risk Scoring Form (Coopland et al. 1977) fig1. The 107 pregnant mothers were divided to: Low risk pregnancies 41 (38.32%), High risk pregnancies 48 (44.85 %), and Severe risk pregnancies 18 (16.83 %)

### 3.1. General Statistical Study:

During a 12-month period, 107 pregnant women participated in the study. The cases were divided into 3 groups: 1) Low risk pregnancies 2) High risk pregnancies 3) Severe risk pregnancies. The demographic characteristics of mothers and their neonates are shown in Table 1, in addition to the umbilical Arterial blood values, Apgar score, need of resuscitation and NICU admission.



**COOPLAND'S High Risk Evaluation Form**

Name ----------Age ------ Para ----- Gravida-------LMP----------EDC-----

| Reproductive history | Medical / surgical conditions | Present pregnancy |
|---|---|---|
| Age < 16 years. =1<br>16-35 =0<br>> 35 =2<br>Parity 0 = 1<br>1-4 = 0<br>>5 = 2<br>Two or more abortions/ history of infertility = 1<br>Postpartum bleeding/manual removal of placenta = 1<br>Prior child wt<5 lb./ >9 lb. =1<br>Toxaemia or hypertension =2<br>Previous cesarean section=2<br>Abnormal / difficult labour =2<br><br>COLUMN TOTALS<br>Total Score ------<br>Low risk 0-2 | Previous gynaec. surgery = 1<br>Chronic renal decease = 1<br>Gestational diabetes(A) =1<br>Class B/ greater diabetes = 3<br>Heart disease = 3<br><br>Other significant medical disorders (score 1 to 3 according to severity)<br><br>High risk 3-6 | Bleeding<br>< 20 wks. = 1<br>> 20 wks. = 3<br>Anaemia<br><10 g% = 1<br>Postmaturity = 1<br>Hypertension = 2<br>Premature rupture of membranes = 2<br>Ployhydramnios = 2<br>IUGR = 3<br>Multi.pregnancy = 3<br>Breech / Malpresentation =3<br>Rh mismatch = 3<br><br>Severe risk ≥ 7 |

**Fig 1: Coopland's High risk evaluation form.**

**Table 1: General statistical study of study groups**

| | **Prenatal High Risk Scoring Form** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **<= 2** | | | | **3 - 6** | | | | **7+** | | | |
| | **Mean** | **Standard Deviation** | **Count** | **Row N %** | **Mean** | **Standard Deviation** | **Count** | **Row N %** | **Mean** | **Standard Deviation** | **Count** | **Row N %** |
| **Age** | 24.45 | 5.39 | 41 | 38.32 % | 28.04 | 6.68 | 48 | 44.85 % | 32.03 | 7.49 | 18 | 16.83% |
| **Gestational age** | 37.66 | 2.19 | 41 | 38.32 % | 36.52 | 1.87 | 48 | 44.85 % | 36.71 | 1.72 | 18 | 16.83% |
| **PH** | 7.24 | 0.05 | 41 | 38.32 % | 7.25 | 0.05 | 48 | 44.85 % | 7.23 | 0.05 | 18 | 16.83% |
| **PCO2** | 50.75 | 7.41 | 41 | 38.32 % | 52.31 | 8.91 | 48 | 44.85 % | 56.07 | 10.66 | 18 | 16.83% |
| **PO2** | 14.49 | 6.54 | 41 | 38.32 % | 13.72 | 5.78 | 48 | 44.85 % | 13.61 | 7.13 | 18 | 16.83% |
| **HCO3** | 20.95 | 3.81 | 41 | 38.32 % | 22.41 | 3.46 | 48 | 44.85 % | 22.67 | 2.35 | 18 | 16.83% |
| **Base Deficit** | 5.66 | 2.75 | 41 | 38.32 % | 4.95 | 2.32 | 48 | 44.85 % | 5.20 | 2.96 | 18 | 16.83% |
| **Apgar min 1** | 8.57 | 1.33 | 41 | 38.32 % | 8.66 | 1.27 | 48 | 44.85 % | 7.94 | 1.41 | 18 | 16.83% |
| **Apgar min 5** | 9.54 | 1.04 | 41 | 38.32 % | 9.62 | 0.86 | 48 | 44.85 % | 9.23 | 1.29 | 18 | 16.83% |
| **resuscitation care** | **N** | | 27 | 35.06 % | | | 38 | 49.35% | | | 12 | 15.58% |
| | **Y** | | 14 | 46.67 % | | | 10 | 33.33% | | | 6 | 20.00% |
| **NICU** | **N** | | 25 | 34.25 % | | | 36 | 49.32% | | | 12 | 16.44% |
| | **Y** | | 16 | 47.06 % | | | 12 | 35.29% | | | 6 | 17.65% |
| **Birth weight** | 3079.4 | 324.1 | 41 | 38.32 % | 3052.8 | 373.8 | 48 | 44.85 % | 3051.4 | 343.5 | 18 | 16.83% |

### 3.2. Predicting Apgar score based on pH values of the umbilical arterial blood:

We study the ability of pH value to predict Apgar score in the 1 min and 5 min, using Wilk's – Lambda which shows:

3.2.1. 1st min Apgar score: The Wilk's – Lambda symbol can predict with high significance $\chi^2 = 17.730, p < 0.01$ and $R^2 = 39.2\%$, that means pH value was able to explain $39.2\%$ of the 1st min Apgar changes. Correlation between pH and 1st min Apgar score was $R = 62.61\%$. Furthermore, sensitivity was 72.73% and specificity was 77.55%

3.2.2. 5th min Apgar score: The Wilk's – Lambda symbol cannot predict $\chi^2 = 3.733, p > 0.05$

### 3.3. Predicting pregnancy outcomes based on pH values of the umbilical arterial blood:

We study the ability of pH value to predict the need of need for resuscitation and admission to the newborn ward or Neonatal Intensive Care Unit, using Wilk's – Lambda which shows:

3.3.1. Need for resuscitation: The Wilk's – Lambda symbol can predict with high significance $\chi^2 = 71.802, p < 0.01$ and $R^2 = 70\%$ that means pH value was able to explain $70\%$ of the changes. Correlation between pH and neonate need for resuscitation was $R = 83.67\%$. Furthermore, sensitivity was 90.32% and specificity was 85.90%

3.3.2. Admission to the newborn ward or Neonatal Intensive Care Unit: The Wilk's – Lambda symbol can predict with high significance $\chi^2 = 44.910, p < 0.01$ and $R^2 = 58.7\%$ that means pH value was able to explain 58.7% of the changes. Correlation between pH and admission to the newborn ward or NICU was $R = 67.62\ \%$. Furthermore, sensitivity was 77.14% and specificity was 83.78%

### 3.4. Discussion:

In the current study, umbilical artery sampling was done after clamping the umbilical cord immediately after birth, analysis of arterial blood gases was performed within 30 minutes of birth (pH, PCO2, PO2, HCO3, Base Deficit). Cases were divided based on the pH value of the umbilical artery at a cutoff value of 7.2. The study showed that there were statistically significant differences between the studied parameters according to the pH values of umbilical cord blood (P <0.01).

34 neonates (31.7%) were admitted to the newborn ward or Neonatal Intensive Care Unit The most frequent diagnosis was: hypoxia (fetal distress) 50% (17 cases), prematurity and related complications 14.7% (5 cases), transient tachypnea of the newborn TTN 17.6% (6 cases) and other causes such as jaundice 11.7% (4 cases). Two cases of death were recorded within a week of observation 5.8%.

The study showed a correlation between pH values of the umbilical artery and Apgar score in the first minute $R = 62.61\%$, the need for neonatal resuscitation $R = 83.67\%$ and admission to the newborn ward or Neonatal Intensive Care Unit $R = 67.62\ \%$ ($p < 0.01$ respectivly). However, the current study did not show a correlation between pH values of the umbilical artery and Apgar score in the fifth minute, which reflects the effectiveness of resuscitation applied to the newborn.

## IV. CONCLUSION

Analysis of arterial blood gases and pH of the umbilical cord or neonatal circulation during the first minute of life is the best method for objective evaluation of hypoxia and acidosis before birth. Sampling from the umbilical cord does not harm newborns and is relatively inexpensive. The results will provide useful and immediate information to the medical staff to improve their performance and experience regarding intrapartum monitoring. It is recommended that these tests be performed in all cases where fetal oxygenation/acidosis is suspected with/or low Apgar score.

Umbilical pH value correlates with Apgar score and may serve as sensitive indexes together with Apgar score for the diagnosis of neonatal asphyxia. Apgar score reflects the respiratory, cardiovascular and

neurological functions of newborns, and decreases when these organs experience severe and prolonged hypoxia. Apgar score in the first minute is an important indicator of start resuscitating the fetus, but the 5$^{th}$ min Apgar score has weak correlation with hypoxia / acidosis in the uterus, and can reflect the effectiveness of resuscitation applied to the newborn.

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