

## Original Article

# The value of umbilical artery blood gas analysis in the diagnosis and prognosis evaluation of fetal distress

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**Abstract:** To explore the diagnostic specificity and clinical application of neonatal umbilical cord blood gas analysis in the prognosis of fetal distress, and to provide theoretical basis for neonatal rescue. Clinical data of a total of 240 singleton pregnant women and their neonates who delivered in the Obstetrics Department of our hospital from January 2021 to December 2021 were retrospectively analyzed. The pregnant women and their newborns were divided into an acute group (acute fetal distress), a chronic group (chronic fetal distress) and a control group (no fetus distress), with 80 cases in each. The umbilical artery blood gas analysis values including power of hydrogen (PH), partial pressure of carbon dioxide (PCO<sub>2</sub>), partial pressure of oxygen (PO<sub>2</sub>), bicarbonate radical (HCO<sub>3</sub><sup>-</sup>), buffer excess (BE) and the Apgar score, as well as the neonatal asphyxia outcome after birth were recorded. There were statistically significant differences in fetal condition, PH and BE between newborns with asphyxia and normal newborns (P<0.05). The incidence of neonatal distress was 1.25% in the control group and 19.38% in the fetal distress group (including acute and chronic groups). Logistic regression analysis found that fetal distress was a risk factor for neonatal asphyxia (Odds Ratio (OR)=11.064, P=0.012). The specificity and sensitivity of neonatal cord blood gas analysis in diagnosing neonatal asphyxia were 95.69% and 80.65%, respectively. The specificity of Apgar score in the diagnosis of neonatal asphyxia was 94.74%, and the sensitivity was 70.97%. The rate of neonatal asphyxia in the chronic fetal distress group (26.25%) was higher than that in the acute fetal distress group (12.5%). The proportion of neonatal severe asphyxia in the chronic fetal distress group (66.67%) was higher than that in the acute group (20%). The PH and BE levels in the chronic fetal distress group were lower than those in the control group and acute fetal distress group (P<0.05). Cord blood gas analysis can help to improve the accuracy of fetal distress diagnosis. Cord blood gas is closely related to neonatal prognosis. Compared with acute fetal distress, chronic fetal distress is more likely to lead to neonatal acidosis and asphyxia.

**Keywords:** Umbilical artery blood gas analysis, fetal distress, diagnosis, prognosis

## Introduction

Fetal distress is a syndrome of fetal hypoxia and/or acidosis in the womb, and one of the main causes of neonatal respiratory distress syndrome, perinatal death and long-term disability. It is often caused by the obstruction of blood oxygen transfer and exchange between mother and fetus due to low maternal blood oxygen concentration, abnormal fetal factors or degenerative changes such as in the placenta. According to the time of occurrence, fetal distress can be divided into acute fetal distress and chronic fetal distress. With the increase in pregnancy complications and medical diagnosis rates, the statistical incidence of fetal dis-

tress is 2.7% to 38.5% [1]. Some studies have shown that if the time from the discovery of fetal distress to timely delivery is within 2 hours, only 15.65% of newborns will experience neonatal asphyxia [2]. For those who deliver within 2 to 6 hours, the neonatal asphyxia rate reaches 29.63%. For those who are treated for more than 10 hours, neonatal asphyxia can reach 42.86%, and intrauterine distress will also increase the incidence of neonatal acidosis due to prolonged hypoxia, resulting in a poor prognosis [3]. Therefore, if fetal distress is not corrected or properly treated in time, it will not only easily lead to a decrease in fetal blood oxygen concentration and acidosis, which may cause neonatal asphyxia, but also lead to stillbirth in

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the uterus or after birth. It is the main cause of perinatal death and the main cause of poor prognosis such as neonatal neurological damage and cerebral palsy.

In recent years, the clinical application value of neonatal umbilical arterial blood gas analysis has gradually attracted the attention of the perinatal medical community. Arterial blood gas analysis mainly analyzes indicators such as power of hydrogen (PH), partial pressure of carbon dioxide ( $PCO_2$ ), partial pressure of oxygen ( $PO_2$ ), bicarbonate radical ( $HCO_3^-$ ), alkali surplus and anion gap. The results obtained are objective. The oxygen needed by the fetus comes from the maternal umbilical cord and placenta supply. When the oxygen supply cannot meet the needs of the fetus, anaerobic metabolism will be enhanced, resulting in excessive  $CO_2$  and lactic acid metabolites. The blood buffer system in the fetus is mainly carbonic acid. The hydrogen salt buffer system and the hemoglobin buffer system cannot completely remove excess acidic substances to adjust the acid-base balance in the body and this causes acidosis. Of course, fetal PH can also change due to changes in maternal PH, which is also transmitted through the placenta. When the placenta is dysfunctional or causes exchange dysfunction, the fetal buffer system comes into play. If the mother is hyperventilated during delivery, the  $PCO_2$  may drop, the PH value will rise instantaneously, and respiratory alkalosis may occur. At this time, the placenta's ability to be permeable to  $CO_2$  is enhanced, and material metabolism is carried out [4]. When the maternal  $CO_2$  retention occurs due to respiratory obstruction and other reasons, respiratory acidosis can also occur, and the fetus is born with an increase in  $PCO_2$  and a decrease in PH [5]. Therefore, the fetus can change correspondingly with the changes of the acid-base ratio of the mother. Therefore, the acid-base status and blood oxygen partial pressure of the fetus can be intuitively used as indicators of acidosis and hypoxia metabolism.

Because the blood flow direction of fetal umbilical artery is from the fetus to the placenta, it reflects the situation of the fetus. The blood flow direction of umbilical vein is from placenta to fetus, which reflects the placental function and acid-base balance of pregnant women. Therefore, when monitoring the status of newborns in clinic, most measure the umbilical

arterial blood gas analysis value, so as to directly reflect the acid-base status, gas and material metabolism of newborns. The interpretation of umbilical cord blood gas analysis results can preliminarily determine the acid-base situation in blood by measuring the  $H^+$  concentration in blood gas samples, and then classify acid-base poisoning by  $HCO_3^-$ ,  $PCO_2$  and other indicators dissolved in blood. Lac and base excess (BE)/base deficit (BD) values can understand the severity of acid-base poisoning, which can directly reflect the lung ventilation function and its acid-base balance state. It is a means to understand the degree of hypoxia and acid-base balance [6]. It is also recognized internationally that taking umbilical cord blood for blood gas analysis and detection after birth is a quantitative analysis method of fetal perinatal stress, which reflects the acid-base balance of newborns in the form of objective indicators, with strong specificity [7].

But so far there is no single sensitive diagnostic index for neonatal asphyxia, and there is no unified standard for clinical evaluation in obstetrics to improve perinatal outcomes. At present, self-measured fetal movement, EFM, BPP, etc. are often used to monitor fetal intrauterine hypoxia before and during delivery in China, while the traditional simple Apgar score is often used to diagnose the degree and prognosis of asphyxia after birth. The Apgar scoring system was proposed by the anesthesiologist Apgar in the 1950s and is one of the oldest and the most commonly used assessment tools for assessing the need for intervention for neonates and in the delivery room [8]. Since the Apgar score is self-evaluated by midwives or obstetricians, the evaluation score is highly subjective. A misdiagnosis rate of 50%-80% has been reported, showing high sensitivity but low specificity [9]. Also, it is easily affected by many other factors, so it is not suitable for neonates undergoing endotracheal intubation. Since the Apgar score does not usually reflect the degree of acidosis at delivery, its value in the assessment of asphyxia must be questioned. Zaigham et al. [11] have clearly pointed out that a low Apgar score is not equivalent to neonatal asphyxia. If the Apgar score is simply used to diagnose neonatal asphyxia, it is a misunderstanding and abuse of the Apgar score. The Apgar score alone cannot predict the outcome of poor neonatal prognosis, nor can it predict neonatal mortality [12]. It is also inac-

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**Table 1.** Comparison of general data among the three groups ( $x \pm s$ )

Group	n	Age (years)	Gestational week (weeks)	Delivery way (cesarean section/vaginal delivery)
Control group	80	27.43±2.55	38.7±0.6	40/40
Chronic fetal distress group	80	27.74±2.66	38.5±0.6	47/33
Acute fetal distress group	80	27.63±2.62	38.6±0.5	51/29
F		0.290	2.474	3.171
P		0.749	0.086	0.205

curate to use the Apgar score to classify neonates with asphyxia into severe asphyxia or mild asphyxia and to judge whether neonates have multiple organ damage or metabolic acidosis [13]. In contrast to the shortcomings of the Apgar score described above, neonatal umbilical artery blood gas value can directly reflect blood oxygen content and acid-base status, with strong specificity, which can make up for the deficiency of Apgar score that is easily affected by various factors. Therefore, some researchers have recently proposed [14] that in order to increase the specificity and sensitivity of the diagnosis of neonatal asphyxia, it is recommended to increase the routine comprehensive diagnosis of neonatal asphyxia by adding neonatal umbilical cord blood gas analysis. If the diagnosis rate of neonatal asphyxia after birth in patients with fetal distress can be improved, the risk can be reduced, the specificity can be improved, and the cause of neonatal depression can be distinguished, which is particularly important in the treatment and prognosis of neonatal asphyxia caused by fetal distress. According to a report presented in Chinese, the incidence of neonatal distress in high elevation plateau areas (12.27%) was significantly higher than that in flat areas (3.59%). Zunyi is a plateau area, so this study analyzed the value of umbilical cord blood gas analysis in the diagnosis and prognosis of fetal distress in this area.

## Methods

### Clinical information

This study retrospectively analyzed the clinical data of 240 singleton pregnant women and their neonates who were delivered in the Obstetrics Department of our hospital from January 2021 to December 2021. Inclusion criteria: ① Singleton live birth; ② Regular obstetric examinations during pregnancy; ③ Complete follow-up records. Exclusion criteria: ① A

large number of analgesics and sedatives were used during delivery; ② The neonates had congenital diseases, chromosomal abnormalities or malformations; ③ Incomplete clinical or follow-up data; ④ Neonatal asphyxia caused by other high-risk factors. According to the relevant diagnostic criteria and classification criteria in the 9th edition of *Obstetrics and Gynecology*, the pregnant women and their newborns were divided into an acute group (acute fetal distress), a chronic group (chronic fetal distress) and a control group (no fetus distress), with 80 cases in each group. Acute fetal distress occurs during labor and is often caused by umbilical cord prolapse, placenta previa, placental abruption, prolonged labor or strong and uncoordinated contractions. Chronic fetal distress mostly occurs in the third trimester of pregnancy due to hypertensive diseases of pregnancy, chronic nephritis, diabetes, severe anemia, intrahepatic cholestasis of pregnancy and overdue pregnancy. There were no statistically significant differences in the general data of the three groups of pregnant women, so they were comparable (Table 1). This study was approved by the medical ethics committee of the hospital (Approval number: 157), and all pregnant women were informed and signed the informed consent.

### Newborn umbilical artery blood gas analysis collection and detection methods

When the newborn was born but had not yet established spontaneous breathing, because delaying the umbilical cord cutting increases the number of neonatal red blood cells, the umbilical artery blood was collected from the fetal side first, and the cord blood was analyzed, and then the umbilical cord was cut after the umbilical artery fluctuation disappeared. If the newborn's reaction after birth was poor and they were in need of rescue. We immediately used two sterilized hemostatic forceps to clamp the umbilical cord on one side of the pla-

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centa and quickly squeezed the umbilical cord blood into the fetus for rescue. The umbilical cord was cut off at the outside of the umbilical cord, and the assistant used a heparinized syringe to puncture the umbilical artery for umbilical blood gas analysis. Because the blood flow of the fetal umbilical artery is from the fetus to the placental villi space, it reflects the condition of the fetus. While the blood flow of the umbilical vein is from the placenta to the fetus, and it reflects the acid-base balance and placental function of the mother. Therefore, in the diagnosis of neonatal asphyxia, unified measurement of umbilical artery blood gas can more accurately reflect the blood content and acid-base status of neonates. We collected 0.5-1.0 ml of umbilical artery blood while trying to avoid rapid and forceful suction, so as not to draw in air to affect the index, sealed it immediately after drawing, completed the test within 5 minutes, and obtained the umbilical arterial blood gas analysis value.

### *Diagnostic criteria for neonatal asphyxia*

Referring to the 2013 edition of the 2013 version of the diagnostic and grading criteria for neonatal asphyxia customized by the Neonatal Professional Committee of the Chinese Medical Doctor Association [15], umbilical arterial blood gas analysis PH <7.15 was a necessary condition for neonatal asphyxia, as well as normal PO<sub>2</sub> >14 mmHg, PCO<sub>2</sub> <65 mmHg, HCO<sub>3</sub><sup>-</sup> in 15-30 mEq/L and Lac <4 mmol/L.

### *Diagnostic criteria for Apgar score*

The Apgar score was based on the appearance, pulse, grimace, and activity within 1 minute after birth. Respiration was based on 5 physical signs, each of which was scored from 0 to 2 points, with a full score of 10 points. A newborn with an Apgar score greater than or equal to 8 points was a normal newborn, and a newborn with an Apgar score of 4 to 7 was considered to have mild asphyxia, and with an Apgar score of less than 4 points was considered to have severe asphyxia [16]. Scores were performed by our obstetrician-trained obstetricians and midwives in the delivery room or operating room.

### *Observation indicators*

We recorded the umbilical arterial blood gas analysis values (PH, PCO<sub>2</sub>, PO<sub>2</sub>, HCO<sub>3</sub><sup>-</sup>, and BE),

the Apgar score, and the outcome of neonatal asphyxia after birth.

### *Statistical methods*

Statistical analysis was performed using SPSS 19.0 software. The distribution of count data was described by frequency and composition ratio (%), and the difference between groups was analyzed by Chi-square test. The normally distributed measurement data were described as the mean ± standard deviation, and the variance analysis was used to analyze the differences between groups. For non-normally distributed measurement data, Median (quartile) was used to describe the distribution, and Kruskal-Wallis rank sum test (Z statistic) was used to analyze the differences between groups. The incidence of neonatal asphyxia was taken as the dependent variable, and the logistic regression model was used to calculate the Odds Ratio (OR) value and 95% confidence interval (CI). The test level was α=0.05.

## Results

### *Comparison of neonatal umbilical artery blood gas analysis indexes among the three groups*

There were significant differences in PH and BE levels among the three groups (P<0.05). It was found that the PH and BE levels in the chronic fetal distress group were lower than those in the control group and acute fetal distress group (P<0.05), while there was no significant difference between the other later groups. In addition, there was no significant difference in PCO<sub>2</sub> and PO<sub>2</sub> among the three groups (P>0.05, as shown in **Table 2**).

### *Fetal distress and neonatal asphyxia*

Univariate analysis showed that there were statistically significant differences in fetal condition, PH and BE between newborns with asphyxia and normal newborns (P<0.05) (**Table 3**). The rates of neonatal distress in the control group and the fetal distress group (including the acute group and chronic group) were 1.25% and 19.38%, respectively. Logistic regression analysis found that fetal distress was a risk factor for neonatal asphyxia (OR=18.98, P=0.004), and the risk of neonatal asphyxia in the fetal distress group was 18.98 times that of the control group (as shown in **Table 4**).

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**Table 2.** Comparison of neonatal blood gas analysis indicators among control, chronic fetal distress and acute fetal distress groups

Group	n	PH	PCO <sub>2</sub> (mmHg)	PO <sub>2</sub> (mmHg)	BE (mEq/L)
Control group	80	7.26±0.048	60.53±6.74	62.23±5.89	-0.13 (-0.16, -0.1)
Chronic fetal distress group	80	6.57±1.60*	62.55±7.49	60.17±5.46	-0.24 (-3.92, -0.21)*
Acute fetal distress group	80	5.85±2.14	61.78±7.12	61.53±5.53	-0.24 (-0.25, -0.23)
F		16.661	1.638	2.776	16.661
P		<0.001	0.197	0.064	<0.001

Note: PH, power of hydrogen; PCO<sub>2</sub>, partial pressure of carbon dioxide; PO<sub>2</sub>, partial pressure of oxygen; HCO<sub>3</sub><sup>-</sup>, bicarbonate radical; BE, buffer excess. \*represents P<0.05 compared with Control group and Acute fetal distress group.

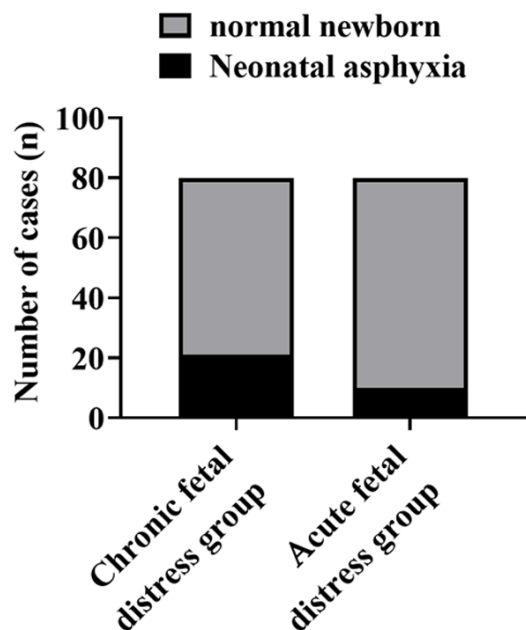
**Table 3.** Univariate analysis of neonatal asphyxia

Factor	Neonates were normal (n=208)	Neonatal asphyxia (n=32)	t/Z	P
Fetal condition				<0.001
normal	79	1		
Acute fetal distress group	70	10		
Chronic fetal distress	59	21	21.707	
Age (years)	27.52±2.54	28.06±2.99	1.092	0.276
Gestational Week (Week)	38.62±0.57	38.69±0.78	0.613	0.541
PH	7.19 (7.16, 7.25)	2.39 (2.07, 3.93)	-5.918	<0.001
PCO <sub>2</sub> (mmHg)	61.59±7.23	61.80±6.63	0.155	0.877
PO <sub>2</sub> (mmHg)	61.32±5.77	61.23±5.09	0.083	0.934
BE (mEq/L)	-0.21 (-0.24, -0.15)	-5.01 (-5.33, 3.47)	-6.853	<0.001

Note: PH, power of hydrogen; PCO<sub>2</sub>, partial pressure of carbon dioxide; PO<sub>2</sub>, partial pressure of oxygen; HCO<sub>3</sub><sup>-</sup>, bicarbonate radical; BE, buffer excess.

**Table 4.** Logistic regression analysis of neonatal asphyxia caused by fetal distress

Variable	Control group (n=80)	Fetal distress group (n=160)	β	Wald	P	OR (95% CI)
Neonatal asphyxia	1 (1.25%)	31 (19.38%)	2.404	6.330	0.012	11.064 (1.701-71.972)



**Figure 1.** Comparison of neonatal asphyxia between the chronic fetal distress group and the acute fetal distress group.

### Comparative analysis of neonatal asphyxia in acute and chronic fetal distress

The rate of neonatal asphyxia in the chronic fetal distress group was 26.25%, which was higher than 12.5% in the acute fetal distress group (P<0.05, as shown in **Figure 1**).

### Evaluation of diagnostic methods of cord blood gas analysis and Apgar score

The diagnostic criteria in the research methods were used to diagnose neonatal asphyxia by neonatal umbilical blood gas analysis and Apgar score. The sensitivity is 25/31 \* 100%=80.65%. The specificity of Apgar score

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**Table 5.** Specificity analysis of umbilical cord blood gas analysis in diagnosis of neonatal asphyxia

Cord blood analysis index	Neonatal asphyxia		Total	x <sup>2</sup>	P
	Yes	No			
PH <7.15	25	9	34		
PH ≥4.15	6	200	206		
Total	31	209	240	129.379	<0.001

**Table 6.** Analysis of specificity of Apgar score in diagnosis of neonatal asphyxia

Apgar Score	Neonatal asphyxia		Total	x <sup>2</sup>	P
	Yes	No			
Apgar Score <7	22	11	33		
Apgar Score ≥7	9	198	207		
Total	31	209	240	98.271	<0.001

**Table 7.** Comparison of the severity of neonatal asphyxia between the chronic fetal distress group and the acute fetal distress group

Group	Neonatal asphyxia		x <sup>2</sup>	P
	Mild asphyxia	Severe asphyxia		
Chronic fetal distress group (n=21)	7 (33.33)	14 (66.67)		
Acute fetal distress group (n=10)	8 (80)	2 (20)	5.907	0.023

for the diagnosis of neonatal asphyxia was 198/209 \* 100%=94.74%, and the sensitivity was 22/31 \* 100%=70.97% (as shown in **Tables 5** and **6**).

### *Analysis of the prognosis of acute fetal distress and chronic fetal distress*

In the acute fetal distress group, the rate of mild asphyxia was 80%, and the rate of severe neonatal asphyxia was 20%. In the chronic fetal distress group, the rate of mild asphyxia was 33.33%, and the rate of severe neonatal asphyxia was 66.67%. In the neonatal asphyxia classification, there was a statistically significant difference between the acute fetal distress group and the chronic fetal distress group (P<0.05, as shown in **Table 7**).

### **Discussion**

The perinatal death and long-term disability rate caused by fetal distress has always been one of the focuses of perinatal medical workers, and the results of this study also concluded that fetal distress is an important cause of neonatal asphyxia. Therefore, if fetal distress can be correctly diagnosed, prevented and treated in time, it will directly affect the pro-

gnosis of perinatal infants. Neonatal asphyxia refers to the occurrence of respiratory and circulatory disorders in newborns after birth, resulting in no spontaneous breathing or failure to establish regular breathing within 1 minute after birth, with hypoxemia, hypercapnia and acidosis as the main pathophysiological changes. Diseases can be caused by a combination of factors, such as maternal factors, childbirth factors, umbilical cord factors, placental factors and fetal factors. Studies have shown [17] that in cases of severe fetal asphyxia, the incidence of damage to different organs is 70% to 100%, and the heart and kidneys are the two most vulnerable organs except the brain. Therefore, neonatal asphyxia can lead to irreversible damage to the central nervous system such as myocardial damage and cerebral ischemia and hypoxia damage, resulting in different degrees of central nervous system sequelae such as cerebral palsy, which seriously threatens the life and health of neonates [18]. According to WHO statistics, 4 million newborns die from birth asphyxia every year [19], and in China, neonatal asphyxia is still one of the main causes of perinatal death and poor neonatal prognosis [20]. In this study, the proportions of neonatal asphyxia outcomes in the fetal distress group and the control group were

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compared and analyzed. From **Table 4**, it can be seen that the OR value of neonatal asphyxia between the two is equal to 11.064, that is, the risk of neonatal asphyxia in fetal distress is 18.98 times that in the normal group. Logistic regression analysis showed that fetal distress was a risk factor for neonatal asphyxia. Therefore, for fetal distress, timely detection, timely diagnosis, correction of fetal distress, timely termination of pregnancy, sufficient monitoring of high-risk mothers during delivery, good first aid work for neonatal asphyxia resuscitation, and active treatment within the treatment time window were necessary to effectively reduce the incidence of neonatal asphyxia, improve the success rate of treatment, and reduce the possibility of poor prognosis.

So far, no unified diagnostic criteria for neonatal asphyxia have been achieved, and the neonatal Apgar score was used as the main reference standard for evaluating neonatal asphyxia in the past [21]. In recent years, neonatal umbilical artery blood gas analysis has attracted the attention of perinatal medical workers. Blood gas analysis is currently an internationally recognized reliable indicator for the detection of fetal acid-base status and hypoxia. The American Academy of Pediatrics has adopted the PH value of neonatal umbilical artery blood as one of the diagnostic indicators of neonatal asphyxia [22]. Neonatal asphyxia is mainly due to damage to multiple organs caused by cellular hypoxia. The fetal respiratory and circulatory disorders lead to hypoxia and ischemia, accumulated  $\text{CO}_2$ , sharply increased  $\text{PaCO}_2$  and decreased PH, also, the body is in a state of acidosis, and cells begin to become anaerobic. Glycolysis increases, and metabolites such as lactic acid accumulate in large quantities. At this time, blood gas analysis can clearly reflect the decrease in blood oxygen content and acidosis in the body. According to **Tables 5** and **6** of this study, the diagnostic criteria in the research methods were used to diagnose neonatal asphyxia by neonatal umbilical blood gas analysis and Apgar score. The specificity of neonatal umbilical blood gas analysis for the diagnosis of neonatal asphyxia was 95.69%, and the sensitivity was 80.65%. The specificity of Apgar score in the diagnosis of neonatal asphyxia was 94.74%, and the sensitivity was 70.97%. Therefore, it is concluded that the neonatal umbilical artery blood gas analysis has higher specificity and sensitivity than the Apgar

score in the diagnosis of neonatal asphyxia. However, the diagnostic specificity of Apgar score obtained in this study is higher than the average of other studies in China. It may be because many neonatal factors and maternal factors that may affect the Apgar score have been included in the exclusion criteria during this study, and the Apgar score was judged by trained obstetricians and midwives in the obstetrics department of our hospital, so there are differences due to human subjectivity. Therefore, the Apgar score obtained has high specificity for neonatal asphyxia. In conclusion, this study shows that the neonatal umbilical artery blood gas analysis has a higher diagnostic value for neonatal asphyxia than the Apgar score.

Clinically, fetal distress is mainly divided into chronic fetal distress and acute fetal distress according to the time of fetal distress in the prenatal and labor stages. Whether it is acute or chronic fetal distress, blood circulation between mother and fetus may be affected, or gas exchange disorders may cause asphyxia and lead to damage to the functions of nerves, muscles, heart and other organs, seriously affecting the growth and development of newborns, causing a poor prognosis. This study analyzed the incidence of neonatal asphyxia in chronic fetal distress and acute fetal distress, and found that the proportion of neonatal asphyxia in the chronic fetal distress group was higher than that in the acute fetal distress group. The severity of neonatal asphyxia of the delivered fetus was further divided into groups, and the outcomes of chronic fetal distress and acute fetal distress were analyzed. It was found that the proportion of severe neonatal asphyxia caused by chronic fetal distress was significantly higher than that in the acute fetal distress group. Its prognosis level is more influential. The results of the analysis may be related to the long-term hypoxia in the mother in chronic intrauterine distress, the increase of anaerobic glycolysis, and the greater possibility of developing metabolic acidosis. The accumulation of lactic acid can cause progressive damage to the vital organs of the fetus, especially the brain and myocardium. Without timely intervention, it may cause serious and permanent damage, such as ischemic hypoxic encephalopathy and even intrauterine stillbirth. At the same time, severe hypoxia can also lead to increased fetal respiratory movement, inhala-

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tion of amniotic fluid, and neonatal aspiration pneumonia after birth, which has a greater impact on prognosis. Therefore, in clinical practice, it is necessary to ask about the medical history more carefully, complete relevant examinations, find out the cause, and accurately judge the classification and severity of fetal distress to reduce the incidence of neonatal asphyxia and perinatal mortality.

The PH value in the umbilical artery blood gas analysis of the newborn can most simply and clearly reflect the acid-base condition in the body. In addition, it can also reflect the hypoxia and hypercapnia of the fetus. The  $PCO_2$ ,  $HCO_3^-$ , and BE values help to identify acid-alkalosis. The changes in  $PaCO_2$  lead to changes in PH and BE, making the body be in a state of acid-alkalosis. Therefore, PH and BE are the results of changes in blood gas and are relatively stable. They are not easily changed in a short time and play an important role in judging the prognosis. Because the BE value has the same meaning as  $HCO_3^-$ , and the BE value has stronger stability than  $HCO_3^-$ , BE can also be used instead of  $HCO_3^-$  for judgment. The PH and BE levels of the three groups were significantly different. The comparison between the two groups found that the PH and BE levels of the chronic fetal distress group were lower than those of the control group and the acute fetal distress group, while the latter two groups had no significant difference in pairwise comparisons. The results of this study showed that the PH of the chronic fetal distress group was significantly lower than that of the control group and the acute fetal distress group, and the BE value was also significantly lower than that of the acute fetal distress group and the control group, which also confirms the conclusions drawn above. Distressed patients suffer from prolonged hypoxia, and ischemia-hypoxic changes lead to acidosis, a high proportion of severe neonatal asphyxia and poor relative prognosis, which requires clinical attention. However, there is no statistical significance between acute fetal distress and the control group, which may be related to the fact that most acute fetal distress occurs during labor or delivery. The research results of Syed et al. showed that low umbilical cord PH of newborns with fetal distress was closely related to low Apgar score at birth and high NICU hospitalization rate [23]. In addition, this study also found

that there was no significant difference in  $PCO_2$  and  $PO_2$  among the three groups. This may be related to the fact that  $PO_2$  and  $PCO_2$  easily fluctuate during delivery, whether it is maternal factors, fetal factors or even operational factors, such as umbilical artery sampling. Too much air drawn will also lead to changes in  $PO_2$  and  $PCO_2$  values. Therefore, it only reflects the instantaneous situation at the time of sampling. Therefore, PH and BE value are often used clinically as stable indicators for judging abnormal cord blood gas. The research results of Armstrong et al. showed that low cord PH in infants who were vigorous at birth and free of cardiopulmonary compromise did not indicate an increased risk of adverse outcome. Infants with PH <7.0 at birth who were not vigorous were at high risk of adverse outcome [24].

The limitation of this study is that the long-term prognosis of neonates with asphyxia was not tracked over time, so it was not possible to analyze the long-term prognosis of neonates with asphyxia.

### Conclusions

Umbilical cord blood gas analysis is helpful to improve the accuracy of fetal distress diagnosis, and umbilical cord blood gas is closely related to neonatal prognosis. Compared with acute fetal distress, chronic fetal distress is more likely to lead to neonatal acidosis and asphyxia.

### Disclosure of conflict of interest

None.

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