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Concentration of the Main Biochemical Blood Indices in Early Postnatal Period

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Abstract

The work deals with the analysis of the umbilical blood samples (120 samples) concerning the concentration of general protein and glucose as the main biological constants of newborns. There is no a reliable difference found between these indices while comparing groups with monocyesis and twin pregnancies. Possible correlation interrelation of certain biochemical indices in newborns during early postnatal period was examined (54 samples). In addition, changes of the examined biochemical indices were followed in the course of time in 19 newborns concerning the comparison of umbilical and venous blood.

Keywords: umbilical blood of monocyesis and twin pregnancy, blood of newborns, glucose, general protein, urea, creatinine, bilirubin, correlation interrelation.

Introduction

Detection of the levels of glucose and general protein concentration in the umbilical blood of newborns is one of the most important homeostatic parameters which is of great value for postnatal adaptation. As a rule, detection of these common biochemical parameters is indicated for the newborns from “risk group”: preterm babies with low body weight, intrauterine hypotrophy, born to mothers suffering from diabetes mellitus or obesity, etc.

According to literary data risk factors of the intrauterine growth and development of the fetus are pre-eclampsy on late terms of gestation, diabetes mellitus, viral infection (usually cytomegalovirus), heart defects with circulatory disorders, which evidently results in disorders of homeostasis including decrease of glucose and general protein levels [1-3].

Literary evidence concerning the norm of protein concentration in term and preterm newborns in the blood serum range approximately within the following values: 46,0 – 68,0 g/L and 36,0-60,0 g/L respectively [1].

As to the question of concordance of glucose standard levels in the blood of newborns, diametrically opposite views are found in scientific literature concerning hypoglycemic importance

of sugar level in the blood, not only depending on gestational age of a newborn and body mass index, type of feeding, region of the study and even daily period of a baby's life activity [3, 4, 6].

In 2000 a group of expert headed by Cornblath M., came to the conclusions that hypoglycemia can be found as a pathologic reaction to glucose insufficiency for the CNS first of all. The safe glucose level in early neonatal period despite the term of gestation is 2,5 mmol/L. These data correspond to the criterion of hypoglycemia according to Shabalov N.P. (2004) – less than 2,6 mmol/L in any time of a day [3]. The study of Anderson D.M.et al. is indicative of hypoglycemia found in 38% of newborns under condition of critical threshold value of 2,6 mmol/L in the first 50 hours of life [3, 5, 8].

It should be noted that the most frequent disorders of glucose metabolism are found in sick newborns, especially preterm ones, causing their susceptibility bot to hypoglycemia and hyperglycemia [1].

Duration of labour period, surgical delivery and even a kind of anaesthesia are able diametrically, in a short period of time, to change the dynamics of glycemia of a newborn [1, 9].

All these factors are topical for Ukraine as well, where the share of preterm labour achieves 5% from general number. At the same time, 10-12% of newborns in Ukraine have their body mass lower than 2500,0 g. Sickness rate in this category of infants is three times higher than that of the category with body weight higher that threshold value of 2,5 kg. These are the infants with insufficient body mass that are characterized by a high risk of disorders of postnatal adaptation processes and following possibility to develop numerous pathological conditions, which stipulates the necessity to correct the processes of life activity including metabolic disorders [7].

Approximately one third of newborns with the body weight less than 2,5 kg is infants with retardation of intrauterine growth and development. With the aim to unify the requirements and capacity to the quality of medical care of newborns with low body mass the Order of the Ministry of Public Health of Ukraine № 584 dated 29.08.2006 «On the Approval of the Protocol of Medical Care of a Newborn with a Low Body Mass at Birth» was introduced, where the critical glucose level ranges within 2,2 – 2,6 mmol/L [7, 8].

A normal glucose level for newborns according to this Protocol is within the ranges of 2,6 to 5,5 mmol/L. Glucose level in the blood of newborns is recommended to be measured by means of gluco-test, in case the result of 2,6 mmol/L and lower is obtained, laboratory detection is recommended with the use of unified methods to prevent physiological conditions of hypoglycemia [7].

Not the least of the factors is that glucose level in the blood plasma is by 18% higher than in the whole blood, in addition, hyperbilirubinemia and hemolysis result in false reduction of glucose concentration with the use of test-strips and reliability of results become lower to 75-85% [3].

Materials and methods

During the period from April 2014 to June 2015 on the base of biochemical laboratory at the Department of Anaesthesiology with intensive care units of the Municipal Clinical Maternity Home №1, the town of Chernovtsy (Ukraine), 120 samples of umbilical blood of newborns were examined to detect the concentration of general protein and glucose according to the Protocols of management of newborns. Among those samples there were blood from 14 pairs from the category of twins (n = 28). For further correction of metabolic processes and dynamics of treatment of newborns 54 samples of venous blood of infants were examined. It should be noted that in 15 individuals from this number the examinations of the concentration of general protein and glucose were made at least twice: in the umbilical blood and then – in the blood of a newborn. In four cases metabolic changes of the concentration of general protein and glucose were made only in the venous blood serum as at the moment of birth there were no necessity to conduct these biochemical examinations.

Moreover, in the blood serum of newborns and in two samples of umbilical blood the concentrations of urea (n = 34) and creatinine (n = 27) were examined.

Umbilical blood was taken by obstetricians in the labour ward immediately in the first minutes after birth of a baby. Venous blood was taken by the medical staff in the Department of intensive care of newborns.

For further examination blood was delivered as soon as possible to the laboratory, centrifuged at 1500-2000 rotations per minute to get serum.

The concentration of metabolites in the blood serum was detected by means of unified common methods with the use of reagent sets of the firm "Reagent", Dnepropetrovsk, Ukraine: protein concentration – by biuretic method, glucose – by enzymatic glucose oxidase one, urea – by enzymatic urease one, bilirubin – by Jendrassik method, creatinine – by kinetic method without deproteinization (Jaffe reaction).

To measure optic density of solutions the photocolorimeter «Solar» PM-1111was used.

Statistical processing was conducted by means of detection of the mean value of indices and their average quadratic deviation with the use of different groups of methods of non-parametric analysis to compare them: the criteria of Spearman, U-Whilkokson-Mann-Whitney, T-Whilkokson. Spearman's rank correlation coefficient was used to detect and estimate the closeness of relations between the number of comparing quantitative indices in the umbilical blood.

T-Whilkokson criterion was used to compare the indices measured in two different conditions on the same sample of the examined objects (umbilical and venous blood of infants).

Results and discussion

Level of general protein in the umbilical blood was within the range from 37,8 g/L to 69,4 g/L. An average amount of general protein concentration in the umbilical blood was 49,6 g/L.

It was an interesting fact that there was no reliable difference in comparison of the indices of general protein and glucose concentration between monocyesis and twin pregnancy by U-Whilkokson-Mann-Whitney criterion (table 1). Vitally important indices were in equal limits of ranging irrespective of a number of developing fetuses.

As to glucose level in the umbilical blood, its concentration was from 2,2 to 5,9 mmol/L. Seven results out from 120 characterized glucose concentration equal or lower than 2,6 mmol/L, but not lower than 2,2 mmol/L (2,2 ≤ glucose ≥2,6). Three from these hypoglycemic indices belonged to twins.

Table 1: Concentration of certain biochemical indices in the umbilical blood of monocyesis and twin pregnancy

		General protein (g/L)	Glucose (mmol/L)	General bilirubin (mkmol/L)
Monocyesis (n=92)	M ± m	49,60 ± 0,78	4,20 ± 0,12	40,39 ± 2,21 (n=40)*
Twins (n=28)	M ± m	49,60 ± 0,93	3,73 ± 0,18	36,53 ± 3,29 (n=12)*

* – amount of concentration detection of general bilirubin level in the serum of umbilical blood.

As Table 1 shows the amount of concentration detection of general bilirubin level is substantially lower than the indices of general protein and glucose. Bilirubin in this series of examinations was secondary index and was indicative of a possible group or rhesus conflict in "mother-baby" system against the ground of primary problem of immaturity of a newborn organism or any other disorders of postnatal adaptation.

It is interesting that one index of glucose in the umbilical blood was 9,2 mmol/L. The mother of this infant was afflicted with type I diabetes in anamnesis, obesity (body weight more than 120 kg), hypertension, and as a result, pre-eclampsy on late terms of gestation. The woman stayed in the hospital for about two months in the department of pathology of pregnancy and anaesthesiology with beds for intensive care therapy (delivery by means of cesarean section).

Literary sources are indicative of a reverse relation between sugar level in the blood of newborns and degree of obesity in mothers. In case of carbohydrate metabolism pathology the frequency of hypoglycemia achieves 38,5 ± 14,0 % [4]. In addition, in infants born to mothers with insulin-dependent diabetes mellitus or experienced diabetes of pregnancy, transitory hypoglycemia develops.

Our case of excluded from rules, and we could not but mentioned it, but further detection of glucose in this infant by glucose-oxidase laboratory method was not performed.

According to the statistics we have not found the interrelations between the indices of general protein and glucose in the umbilical blood both in monocyesis and twin pregnancies. On the basis of scientific literary data concerning this question, in infants with much lower glucose level in the

umbilical blood the lower indices of general protein were registered more frequently statistically [2]. It should be noted that our study included only 120 blood samples as compared with 331 samples described in the study performed by Karpov F.L. and Miroshnichenko O.A. In addition, the group of 331 newborns included only healthy term infants. Our criterion of the study was the fact to detect these indices in the blood of newborns irrespective of their gestational age and baby's condition (prescribed by a neonatologist). The authors of the investigation indicate to the interrelations of these important biochemical indices from the view of supplying energy balance in the organism of a newborn [2, 10].

Examination of infants in their first hours of life demonstrated how fulminant (in the first hours of the first day) and characteristically pronounced the changes in the blood system were. Duration of labour stress, oxygen insufficiency influence upon the dynamics of blood indices greatly [9].

To characterize metabolism and control the treatment in newborns, in addition to the indices of glucose, general protein and bilirubin, the concentrations of urea and creatinine were detected as required. While comparing these indices by Spearman's correlation criterion we have got the results presented in Table 2.

According to these data, there was an average connection between the levels of general bilirubin and urea (r = 0,57), as well as between bilirubin and creatinine (r =0,57); a moderate connection between urea and creatinine (r = 0,40) in the venous blood of newborns found.

In healthy infants physiological jaundice may occur against the ground of immature liver (enzymatic systems). Increased bilirubin level in the blood of preterm newborns does not depend on the body mass at birth, but it correlates directly with the stage of fetus maturation and maternal diseases during pregnancy. The correlation between pigment and nitrous metabolism in newborns is indicative of the formation of important functional systems of the liver involving in the regulation of the main metabolic ways.

Table 2: Correlation of the venous blood indices in newborns in early postnatal period by Spearman's correlation criterion

	General protein (g/L) (n = 54)	Glucose (mmol/L) (n = 41)	General bilirubin (mcmol/L) (n = 19)	Urea (mmol/L) (n = 34)	Creatinine (mcmol/L) (n = 27)
General protein (g/L)	---	-0,004	0,1063	-0,215	-0,053
Glucose (mmol/L)	---	---	0,0629	0,1323	0,1936
General bilirubin (mcmol/L)	---	---	---	0,5714*	0,5714*
Urea (mmol/L)	---	---	---	---	0,4042*
Creatinine (mcmol/L)	---	---	---	---	---

Note: * – reliable correlation between the indices ($p < 0,05$).

Nitrous metabolism in children differ by a number of peculiarities, and a positive nitrous balance as an essential condition of growth in particular. The intensity of nitrous metabolism processes during the infant's growth undergoes considerable changes: during the first three days of life nitrous balance is negative, which is explained by insufficient intake of protein with food. In this period transient increase of residual nitrogen concentration in the blood is found. Physiological creatinuria is characteristic feature. Creatine is found even in amniotic fluid; it is found in urine in the amounts higher than its content in the urine of the adults beginning from the neonatal period to the age of puberty. In the first days of life newborns may display transient peculiarities of metabolism characterized by proteinolysis (hypoproteinemia) together with hypoglycemia. In our case the level of urea concentration about 7,0 mmol/L is the characteristics of transient conversion from the intrauterine to neonatal period of life.

Unfortunately, according to the protocols of management of newborns and requirements of neonatologists we have not conducted the study concerning the concentration of urea and creatinine in the umbilical blood.

Analysis of literary data is indicative of the fact that the content of biochemical indices in the umbilical blood of newborns from the control group ranges within the standard indices of various sources, except the level of urea which was by 30% (5,2 mmol/L) lower than that of an average-standard one. It proves the necessity to work out personal standard indices for every laboratory considering the peculiarities of the cohort, region and other environmental conditions [11].

We had the opportunity to compare the main biochemical indices in the umbilical blood and blood of newborns in early postnatal period between themselves in 19 individuals. In addition to the examination of the umbilical blood at the moment of birth, the main biochemical constants in the venous blood were detected in those infants one time. It was made in 11 individuals and eight times twice (five cases) or even three times (three cases) depending on the severity of an infant's condition or the necessity to correct metabolism.

Table 3 presents the results of examination of correlative changes in biochemical indices of infants depending on the period of their life.

According to T-Whilkokson's criterion there are reliable changes between the concentration of protein in the umbilical blood and in the venous blood of an infant during the first blood sampling ($p < 0,05$). But during further detection of general protein levels in one and the same infant: blood №1 and №2, reliable changes between them were nor found. As to glucose reliable changes between the umbilical blood and venous blood were not found as well as in different samples of the venous blood in early postnatal period of infants' life.

We did not take into account two indices of the concentration of urea and creatinine in the umbilical blood serum as single parameters.

Table 3: Comparison of the dynamics of main biochemical indices in newborns in the process of their vital activity (M ± m)

	General protein (g/L)	Glucose (mmol/L)	General bilirubin (mcmol/L)	Urea (mmol/L)	Creatinine (mcmol/L)
Umbilical blood	48,15 ± 2,22	4,14 ± 0,24	33,8 ± 3,04	---	---
Infant's blood (№1)	50,19 ± 1,89	4,76 ± 0,42	159,82 ± 33,70	7,00 ± 1,06	108,93 ± 42,92
Infant's blood (№2)	49,53 ± 1,70	3,40 ± 0,33	130,53 ± 33,83	7,11 ± 1,49	144,20 ± 83,11

Note: blood № 1 and №2 – in one and the same individual in different periods of time.

There were no sufficient data to compare the indices of urea and creatinine.

It stipulates certain interest to further accumulation of a number of studies which will include no less than 300 samples of the umbilical blood and 150 samples of the venous blood for analytical and correlation analysis of biochemical constants including the activity of aminotransferase enzymes (ALT, AST) as important indices in liver metabolism (transamination reaction) and inclusion of protein products (amino acids) in the process of gluconeogenesis.

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Концентрация основных биохимических показателей крови в раннем постнатальном периоде

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Аннотация. В работе проведен анализ образцов пуповинной крови (120 образцов) относительно концентрации общего белка и глюкозы, как основных биохимических констант новорожденных. Показано, что нет достоверной разницы между этими показателями при сравнении в группах одноплодных и двойни. Исследована возможная корреляционная взаимосвязь некоторых биохимических показателей у новорожденных в раннем постнатальном периоде (54 образца). Кроме того, рассмотрены изменения исследованных биохимических показателей во временном периоде у 19 новорожденных при сравнении пуповинной и венозной крови.

Ключевые слова: пуповинная кровь одноплодных и двойни, кровь новорожденных, глюкоза, общий белок, мочевина, креатинин, билирубин, корреляционная взаимосвязь.