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ORIGINAL ARTICLE

The assessment of clinical and laboratory complications in newborns of diabetic mothers and proposal of a manual for obtaining anamnestic data (about newborn) for a neonatologist

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ABSTRACT

Diabetes mellitus (DM) is one of the most common metabolic disorders in pregnancy. In infants of diabetic mothers, the morbidity and incidence of complications are increased in the prenatal, perinatal and neonatal periods, but also in the later period of life. The aim of this study was to analyse prenatal and postnatal neonatal complications. The study consisted of 96 newborns who were hospitalized from January 1st 2017 to June 30th 2020. 81.3% of newborns were born to mothers with gestational diabetes. 61.5% were born by Caesarean section. Macrosomia was diagnosed in 15%, birth trauma occurred in 24% of cases. Respiratory distress syndrome developed in 34.4% of neonates, syndrome of persistent pulmonary hypertension in 10.4%, congenital heart disease was present in 35.4%. The most common was persistent ductus arteriosus in 18.75%. Hypertrophic cardiomyopathy was diagnosed in 7 newborns (7.3%), of which 6 times without obstruction and 1 time with obstruction of the outflow tract of the left ventricle. 15.6% had congenital malformation of the digestive system and 12.5% had anomaly of the urinary and genital system. The largest proportion of the congenital malformations of CNS had meningomyelocele (6.25%). Hypoglycaemia was confirmed in 22% and hyperbilirubinemia in 30% of newborns. The obtained results were a source for creating the manual that could help neonatologists or paediatricians in practice, to get a comprehensive picture of a newborn whose mother had DM during pregnancy.

KEY WORDS: newborn of diabetic mother; macrosomia; congenital malformations; hypoglycaemia

Introduction

Diabetes mellitus (DM) is a chronic disease that arises because of the lack of action of insulin due to its absolute or relative deficiency. Hyperglycaemia is the basic manifestation, but there are also complex disorders of metabolism of carbohydrate, fats and proteins (Borovský *et al.*, 2016). In the long term, it causes damage to the function of many internal organs. Characteristics are mainly microvascular complications – diabetic nephropathy, retinopathy, neuropathy. In addition, macrovascular complications also arise due to the accelerated development of atherosclerosis (Češka *et al.*, 2015). The incidence of diabetes mellitus is growing globally and currently more than 7% of the population in Slovakia suffers from this disease (NDP, 2012).

In connection with pregnancy pregestational and gestational diabetes mellitus is distinguished. Pregestational diabetes mellitus is a metabolic disease that is first diagnosed before pregnancy. The most common is type 1 or type 2 diabetes, rarely another type of diabetes. In Europe, about 10% of women have pregestational diabetes, which represents 0.3–0.5% of pregnancies per year, that are complicated by this type (EAPM, 2012).

Type 2 diabetes mellitus in pregnancy was relatively rare in the young female population. However, at present,

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due to the large increase in young patients with type 2 diabetes, obese patients and women with a positive family history, the number of pregnant women with this disease is also increasing (Hájek *et al.*, 2004).

The fact is that newborns of pregnant women with type 2 diabetes have had worse perinatal outcomes than newborns of women with type 1 diabetes. The reason being that type 2 diabetes is often first diagnosed during pregnancy and thus only after a period of important organogenesis and incorrectly considered for gestational diabetes mellitus (Hájek *et al.*, 2004; Pelikánová *et al.*, 2011).

Gestational diabetes mellitus (GDM) is one of the most common metabolic disorders in pregnancy, usually occurring at the interface of the 2nd and 3rd trimesters. It usually disappears spontaneously after birth but only if it is gestational diabetes mellitus (Školka *et al.*, 2018). The incidence of GDM is increasing globally and is also related to an unhealthy lifestyle, lack of physical activity, increased overweight and obesity, and the ever-increasing average age of reproduction in women (Anderlová, Krejčí, Haluzík, 2014).

The disease affects approximately 1–5% of pregnant women, but poses a greater risk to the developing foetus and child than to the mother. Newborns of mothers with diabetes have increased morbidity in the prenatal, perinatal and neonatal periods, but also in the later period of the child´s life, when the mother´s diabetes increases the risk of developing obesity, impaired glucose tolerance and diabetes mellitus, as well as neuropsychological dysfunctions in children and adolescents (Hay, 2012; Ingale, Kakar, Karguppikar, 2017).

Newborn of a diabetic mother may be at risk of various complications, the most serious are congenital malformations, prematurity, macrosomia, asphyxia, difficult postnatal adaptation, birth trauma, respiratory distress syndrome, hypertrophic cardiomyopathy, hypoglycaemia, polyglobulia and hyperbilirubinaemia (Al-Qahtani, 2014; Brucknerová *et al.*, 2017; Hay, 2012; Mahmood & Kayes, 2008; Moore *et al.*, 2020; Salima *et al.*, 2018). Therefore, diabetic newborns are among the high-risk group that requires multidisciplinary and intensive care, and for that it is important to centralize mothers with diabetes mellitus in perinatology centres.

Objective

The aim of this study was to analyse prenatal as well as postnatal neonatal complications and highlight the severity of maternal glucose metabolism disorders and the negative effects on the foetus throughout pregnancy, and the newborn after birth with the focus on the presence of congenital abnormalities, the incidence of which is significantly higher in newborns of diabetic mothers, especially with inadequate glycaemic control before and during pregnancy.

The next aim of this study was to create a proposal of a manual that could help neonatologists or paediatrician in practice, to get a comprehensive picture of a newborn whose mother had diabetes mellitus during pregnancy.

Methods

This was a study of the prevalence of mortality and morbidity in IDMs, which was realized retrospectively at the Neonatal Department of Intensive Medicine, Faculty of Medicine Comenius University in Bratislava and National Institute of Children´s Diseases. The subjects of the study were 96 newborns who were hospitalized from 1. 1. 2017 to 30. 6. 2020. The condition for inclusion in the study was gestational or pregestational (DM 1, DM 2) diabetes mellitus of the mother.

We evaluated the available information about the mother from the provided medical documentation such as type of DM during pregnancy (type 1 diabetes, type 2 diabetes, gestational diabetes mellitus), treatment of DM during pregnancy (diet, insulin), prenatally administered corticoids (complete dose, incomplete dose, without corticoid administration) and mechanism of delivery (Caesarean section, spontaneous vaginal delivery, induced or instrumental vaginal delivery).

We evaluated basic data about newborns such as gestational age (<37 g. w. – preterm, ≥37–41 g. w. – term, ≥41 g. w. – post term), gender (male, female), postnatal adaptation (Apgar score at 5th minutes), postpartum resuscitation, birth weight and prenatal nutritional status (hypertrophic, eutrophic, hypotrophic), which we evaluated using Fenton percentile graphs.

We also dealt with associated complications in newborns of mothers with diabetes, which included respiratory and cardiovascular complications, macrosomia, or intrauterine growth restriction. We also monitored the incidence of birth trauma, congenital malformations and abnormalities in metabolic and haematological parameters, such as hypoglycaemia, hypocalcaemia, polyglobulia and hyperbilirubinaemia.

Results

In our study, we compared the prevalence of gestational and pregestational diabetes in women. The largest group 78 (81.3%) consisted of mothers, who had diagnosed gestational diabetes mellitus. 18 women (18.7%) had pregestational diabetes mellitus, of which 12 women (12.5%) had type 1 DM and 6 mothers (6.2%) had type 2 DM.

69 women (71.9%) were managed by diet only, while 27 women (28.1%) were managed with insulin during pregnancy.

Corticosteroids before delivery were indicated only in diabetic mothers whose infants were born prematurely. The complete corticoid dose was given to 25 mothers (42.4%), 16 diabetic women (27.1%) received an incomplete dose of corticoids and without corticoid administration, 18 mothers (30.5%).

In this study, 59 diabetic mothers (61.5%) delivere by caesarean section, 30.2% of mothers had spontaneous vaginal delivery, drug-induced labour was in 4.2% of women and assisted vaginal delivery, using vacuum extractor or obstetrics forceps was necessary in 4.2% of mothers. Table 1 shows characteristics of the mothers.

Furthermore, we divided the newborns according to gestational age and found that most IDMs were born before the term, up to 59 (61.5%), 37 newborns (38.5%) were born at term and the post-term newborn was not in our study. The majority were boys, of which there were 64.6% and girls were 35.4%.

Appropriate postnatal adaptation (score 8–10) was in 74 newborns (77%). An Apgar score 4–7 points in the 5th minute of life was reported in 22 patients (23%) and a score less than 3 points has not been described in our study. Resuscitation just after birth was necessary in 45 newborns (47%).

Birth weight of more than 4000 g was recorded in 14 newborns (15%), 41 children (43%) had optimal weight (in the range 2500-3999 g), 28 newborns (29%) had low birth weight (<2500 g), 8 children (8%) had very low birth weight (<1500 g) and the remaining 5 newborns (5%) had extremely low birth weight (<1000 g).

Prenatal nutritional status was assessed using Fenton percentile graphs. Our group included 16 prenatally hypotrophic newborns (17%), 58 prenatally eutrophic newborns (60%) and 22 prenatally hypertrophic newborns (23%). Death occurred in 2 newborns (2.1%). Table 2 shows characteristics of the infants.

Typical complications and related comorbidities in IDMs, which occurred in our study were mainly preterm birth (61.5%), congenital heart disease (35.4%), respiratory distress syndrome (34.4%), birth injuries (24%), macrosomia (15%), transient tachypnoea (14.6%), syndrome of persistent pulmonary hypertension in newborn (10.4%), hypertrophic cardiomyopathy (7.3%) and shoulder dystocia (1%).

In the monitored group, we also focused on diseases and congenital malformations of the respiratory system. In our study, transient tachypnoea occurred in 14 neonates (14.6%), of which 9 patients were born by caesarean section which is considered to be the main risk factor. Respiratory distress syndrome (RDS) was observed in 33 infants (34.4%), of which up to 29 newborns were born prematurely. Exogenous surfactant was administered to 9 preterm infants with RDS and the use of mechanical lung ventilation was required in 21 newborns. PPHN syndrome was diagnosed in 10 children (10.4%), pneumothorax occurred in 2 neonates (2%) and pneumonia in 9 children (9.4%). 7 newborns (7.3%) had bronchopulmonary dysplasia, 1 child (1%) developed pulmonary hypoplasia and we recorded congenital lung abnormality in 2 newborns (2%).

Congenital heart disease was present in 34 newborns (35.4%). The most frequently diagnosed was persistent ductus arteriosus (PDA) in 18 newborns (18.75%), tricuspid regurgitation was diagnosed in 8 children (8.3%), and hypertrophic cardiomyopathy was recorded in 7 children

Table 1. Characteristics of mothers of newborns who were included into the study.

Study characteristics	n=96	%
Type of diabetes		
GDM	78	81.3 %
DM 1	12	12.5 %
DM 2	6	6.2 %
Treatment of DM during pregnancy		
treated with insulin	27	28.1 %
diet only	69	71.9 %
Prenatal corticoids		
full dose	25	42.4 %
partial dose	16	27.1 %
without corticoids	18	30.5 %
Mode of delivery		
caesarean section	59	61.5 %
spontaneous vaginal delivery	29	30.2 %
induced vaginal delivery	4	4.2 %
assisted vaginal delivery (vacuum, forceps)	4	4.2 %

GDM – gestational diabetes mellitus, DM – diabetes mellitus

Table 2. Characteristics of newborns of diabetic mothers.

Study characteristics	n=96	%
Gestational age (weeks)		
pre-term birth (<37 weeks)	59	61.5 %
full-term birth (≥37–41 weeks)	37	38.5 %
post-term birth (≥41 weeks)	0	0 %
Gender		
male	62	64.6 %
female	34	35.4 %
Postnatal adaptation in the 5th minute		
Apgar score 8–10	74	77 %
Apgar score 3–7	22	23 %
Apgar score <3	0	0 %
Resuscitation after birth		
yes	45	47 %
no	51	53 %
Birth weight		
macrosomia (>4000 g)	14	15 %
normal birth weight (2500–3999 g)	41	43 %
low birth weight (<2500 g)	28	29 %
very low birth weight (<1500 g)	8	8 %
extremely low birth weight (<1000 g)	5	5 %
Prenatal nutritional status (Fenton percentile graphs)		
Hypertrophy	22	23 %
Eutrophy	58	60 %
Hypotrophy	16	17 %
Mortality	2	2.1 %

(7.3%), of which 6 times without obstruction and 1 time with obstruction of the outflow tract of ventricle.

In our study, congenital malformations of the alimentary system were diagnosed in 15 newborns, (15.6%) of the total number of 96 monitored newborns. The most common congenital malformation was umbilical and inguinal hernia in 4 newborns (4.2%), Hirschsprung´s disease in 4 children (4.2%), 2 children had duodenal atresia (2.1%) and 2 newborns (2.1%) were diagnosed with atresia of the anus and rectum. Meckel´s diverticulum, volvulus, gastroschisis, omphalocele, oesophageal atresia and hypertrophic pyloric stenosis occurred 1 time (1%). An overview of the occurring congenital malformations of the digestive system in neonates from our study is given in Figure 1.

In the analysed group of newborns, we also monitored the incidence of diseases and congenital malformations of the central nervous system. Intracranial haemorrhage was most commonly diagnosed in 26 newborns (27%) and hypoxic ischaemic encephalopathy in 14 children (14.6%). Convulsions occurred in 8 children (8.3%), brain leukomalacia in 6 cases (6.25%) and hydrocephalus were present in 3 newborns (3.1%). The largest proportion of the congenital malformations had meningomyelocele, which occurred in 6 cases (6.25%), Arnold-Chiari malformation in 2 cases (2.1%) and spina bifida aperta was present in 1 case (1%).

Diseases and congenital malformations of the urinary and genital system were diagnosed in 12 newborns (12.5%) in our study. In 8 cases (8.3%) there was dilatation of the renal pelvis, in 2 cases (2.1%) hydronephrosis and ovarian cyst were present, and 1 case (1%) was diagnosed with renal hypoplasia, dysfunctional megaureter, bladder exstrophy, and ambiguous genitalia (Table 3).

Table 3. Diseases and congenital malformations of the urinary and genital system.

	n = 96	%
dilatation of the renal pelvis	8	8.3%
unilateral	4	4.2%
bilateral	4	4.2%
hydronephrosis	2	2.1%
unilateral	1	1%
bilateral	1	1%
unilateral ovarian cyst	2	2.1%
renal hypoplasia	1	1%
megaureter	1	1%
urinary bladder exstrophy	1	1%
ambiguous genitalia	1	1%

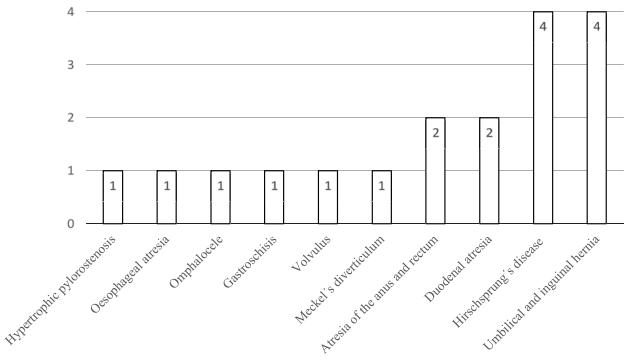

Figure 1. Diseases and congenital malformations of the digestive system of newborns (n=96) of diabetic mothers.

Metabolic and laboratory abnormalities are also common. In the postnatal period, hypoglycaemia was confirmed in 21 newborns (22%), of which intravenous glucose was indicated in 17 children and early enteral intake with breast milk was initiated in 2 children, which provided euglycaemia. Hypoglycaemia as a consequence of transient hyperinsulinaemia due to maternal diabetes was detected in 6 newborns (6.25%). Unconjugated hyperbilirubinaemia was confirmed in 29 neonates (30%), of which phototherapy was indicated in 21 children (21.8%) with ABO or Rh incompatibility. An exchange transfusion was not required in any newborn. Hypocalcaemia was confirmed in 12 newborns and polyglobulia appeared in only 6 children (6.25%).

Discussion

In our study, the majority of the diabetic mothers 78 (81.3%) had gestational diabetes mellitus and pregestational diabetes mellitus was diagnosed in 18 women (18.7%) of this type 1 DM was found in 12 women (12.5%) and the remaining 6 women (6.2%) had type 2 DM. Ullah et al. in his study described that similarly to us, the largest number (81%) consisted of mothers of newborns with GDM, and pregestational diabetes had 19% of ladies (Ullah *et al.,* 2020).

Based on the observations in this study, 59 newborns (61.5%) were born prematurely and 37 newborns (38.5%) were born at term. We associate the high prevalence of premature births with associated diseases of diabetic women in pregnancy, such as hypertension, preeclampsia, and eclampsia, which are common causes of premature birth by mothers (Mathiesen, 2016). In our study, at least one of these complications of pregnancy was present in 26% of mothers of premature babies.

In this study, two-thirds of diabetic mothers (61.5%) delivered by Caesarean section, 30.2% of mothers had spontaneous vaginal delivery, drug-induced labour in 4.2% of women and assisted vaginal delivery, using vacuum extractor or obstetrics forceps was necessary in 4.2% of mothers. Our findings were similar to those of the Brazilian study where the results reported that Caesarean section delivery was in 57.4% cases and 42.6% of women had spontaneous vaginal delivery (Gascho *et al.,* 2017).

Appropriate postnatal adaptation (Apgar score 8-10 points) was in 77% of newborns, score 4-7 was reported in 23% of patients (22 children), of which up to 17 were premature. A score less than 3 points has not been described in our study. Fuka et al. in the results of their cross-sectional study described that in 12.9% of children the Apgar score was less than 7 points after 5th minute of life. The author of this study also found that birth asphyxia occurred more frequently in premature infants,

which may be the cause of the high percentage (23%) in our study (Fuka *et al.,* 2020).

Birth trauma was reported in 24% of the newborns (23 children) included in our study, of which 9 children were born vaginally and 3 newborns were macrosomic. The literature shows that vaginal delivery significantly increases the risk of birth injuries in newborns of mothers with diabetes, especially if the child is macrosomic and weighs more than 4000 g (Moore *et al.*, 2020). However, in our study, shoulder dystocia occurred in only 1 case, it was a macrosomic newborn who weighed 4470 grams and was born spontaneously vaginally.

The literature describes that 15–45% of newborns of diabetic mothers have a macrosomia, defined as a birth weight more than 4000 grams, which occurs mainly due to inadequate glycaemic control during pregnancy (Moore *et al.,* 2020). The number of macrosomic newborns in our group were 15%. Similar results were published by Ingale et al. in their study in which macrosomia was reported in 14% of children (Ingale, Kakar, Karguppikar, 2017). In contrast, a small group of foetuses, less than 5%, are at risk of growth retardation (Nold & Georgieff, 2004).

Prenatal nutritional status was assessed using Fenton percentile graphs. Our group included 23% prenatally hypertrophic newborns, 60% prenatally eutrophic newborns and 17% prenatally hypotrophic newborns. Al-Qahtani in the results of his study described that 21% of children were large for their gestational age (more than 90th percentile), 65% had a weight appropriate to their gestational age (between the 10th and 90th percentiles) an 14% of newborns were small for their gestational age (below the 10th percentile) (Al-Qahtani, 2014).

Salima et al. reported in the results of the study that RDS developed in 25.5% of children and transient tachypnoea was reported in 8.8% of newborns (Salima *et al.,* 2018). In our study, we recorded transient tachypnoea in 14.6% of children. The higher result may be due to the fact that up to 61.5% of newborns were delivered by caesarean section, which is a common cause of insufficient absorption of lung fluid from the lungs after delivery. RDS was diagnosed in 34.4% of newborns, of which only 4 were full-term and up to 29 were pre-term. We hypothesize that our outcome is high due to the delayed lung maturity in newborns of mothers with diabetes (Moore *et al.,* 2020).

To accelerate pulmonary maturation of the foetus, during pregnancy complicated by maternal diabetes, the administration of Dexamethasone is recommended (6 mg intramuscularly in 4 doses every 12 hours) up to the 35th gestational week (Borovský *et al.*, 2016; Ferianec, 2014). In our study, corticoids were administered only to mothers of premature infants. The complete dose was administered in 42.4%, the incomplete dose in 27.1% and 30.5% of the mothers were without corticoid therapy.

In the general population, congenital malformations occur in 1–2% of newborns. In women with diabetes and inadequate glycaemic control before and during pregnancy, the probability of congenital malformations in their foetus increases 4–8 fold. Two-thirds of congenital malformations include anomalies of cardiovascular and central nervous system, but urogenital and gastrointestinal anomalies often occur as well as skeletal abnormalities (Moore *et al.*, 2020). Kallem, Pandita and Pillai published that two-thirds of the congenital anomalies in newborns of diabetic mothers include either anomalies of the cardiovascular system or central nervous system (Kallem, Pandita, Pillai, 2018). Hay describes the incidence of cardiac malformations up to 30% of children in diabetic mothers (Hay, 2012). In our study, congenital heart disease was present in 35.4% of newborns. Most frequently observed was persistent ductus arteriosus (PDA), in 18.75% children. Al-Qahtani published the incidence of congenital heart defects in 14%, most often recorded PDA, similar to our study (Al-Qahtani, 2014). Abu-Sulaiman and Subaih reported PDA in 70% of newborns and hypertrophic cardiomyopathy in 38% of newborns. The incidence of congenital malformations was high because the study analysed only newborns whose mother had type 1 diabetes, which is a significant risk factor for the development of cardiac pathology (Abu-Sulaiman & Subaih, 2004).

Hypertrophic cardiomyopathy was diagnosed in 7 newborns (7.3%) by echocardiographic and Doppler ultrasound scanning in our study, of which 6 without obstruction and 1 with obstruction of the outflow tract of the left ventricle. The exact incidence of hypertrophic cardiomyopathy in IDMs is unclear in most cases, because it is usually asymptomatic (Ornoy *et al.*, 2021). A meta-analysis that analysed 39 studies proved that foetuses of diabetic pregnancies in the third trimester had increased intraventricular septal thickness compared to controls, which points out that hyperinsulinaemia affects the development of the foetal heart (Depla *et al.*, 2020). In these IDMs, we also monitored birth weight, prenatally nutritional status and the blood glucose level, which was measured just after birth. The immeasurable blood glucose level after birth was in 3 newborns and in 2 children the blood glucose level was less than 2.2 mmol/l. Birth weight of more than 4000 grams was confirmed in 4 children and 5 newborns were prenatally hypertrophic. We also focused on type of diabetes mellitus and compensating of diabetes in the mother during pregnancy. In our study, 4 mothers of children with hypertrophic cardiomyopathy had GDM, 2 mothers were treated for type 1 DM and 1 mother was diagnosed with type 2 DM. We found that decompensated diabetes mellitus was confirmed in 3 of 7 mothers. Helle et al. report in their retrospective study, that the severity of hyperglycaemia during the vulnerable first trimester, and thus during the development of the foetal heart, is directly related to a higher incidence of congenital heart disease (Helle *et al.*, 2017).

We also monitored the occurrence of congenital anomalies of the central nervous system in newborns of diabetic mothers. Meningomyelocele had the largest proportion, occurring in 6 cases (6.25%), Arnold-Chiari malformation appeared in 2 cases (2.1%) and spina bifida aperta was present in one case (1%). 26 newborns (27%) were diagnosed with intracranial haemorrhage, 14 newborns (14.6%) had hypoxic ischaemic encephalopathy,

convulsions occurred in 8 newborns (8.3%), brain leukomalacia in 6 newborns (6.25%) and hydrocephalus was diagnosed in 3 newborns (3.1%). Ray et al., observed the occurrence of open neural tube defects (NTD) in mothers without diabetes mellitus and mothers with pregestational diabetes. They found that the presence of diabetes during pregnancy was associated with a higher risk of open NTD. The results show that of 285 newborns, an open NTD was diagnosed in only 4 (1.4%). As many as 68.8% were diagnosed prenatally (Ray *et al.*, 2004). In our study, prenatally diagnosed were only 57% of NTD. Therefore, the most effective way to prevent the development of NTD in the foetus of pregnant women with diabetes is to plan their pregnancy, take folic acid supplement daily and try to maintain adequate blood glucose levels throughout pregnancy (Ray *et al.*, 2004).

Potter and Kicklighter report that gastrointestinal abnormalities, such as duodenal or anorectal atresia, are among the more common congenital malformations in IDMs (Potter & Kicklighter, 2016). We also monitored congenital malformations of the digestive system, which were diagnosed in 15.6% of children. The most common was inguinal and umbilical hernia in 4 children and Hirschsprung´s disease also in 4 children. We also recorded 2 cases of duodenal atresia and 2 cases of anus and rectal atresia. Meckel´s diverticulum, volvulus, gastroschisis, omphalocele, oesophageal atresia and hypertrophic pyloric stenosis occurred in 1 (1%).

Table 4a. Anamnestic and clinical data about newborn and mother with diabetes mellitus – Mother´s characteristics (Gregáňová, 2020).

Anamnestic and clinical data about newborn and mother with diabetes mellitus
Mother´s characteristics
1. Diagnosis of the mother (type of diabetes) ☐ type 1 diabetes mellitus ☐ type 2 diabetes mellitus ☐ gestational diabetes mellitus
2. Pregnancy and compensation during pregnancy **oral glucose tolerance test in 24th–28th gestational week** (plasma glucose level) on an empty stomach (rate ≤5.1 mmol/l): after 1 hour (rate ≤10.0 mmol/l): after 2 hours (rate ≤7.8 mmol/l): **concentration of HbA1c** ☐ <6 % ☐ >6 % **self-monitoring** ☐ yes ☐ no **outpatient diabetes monitoring** glycaemia: examination of urine (glycosuria, ketonuria, proteinuria): microvascular complications: **gynaecological examinations:** **maternal diseases** ☐ hypertension ☐ preeclampsia ☐ eclampsia ☐ urinary tract infections ☐ others: **ultrasound examination:** **diet** ☐ yes ☐ no
3. Prenatally administered corticoids ☐ yes, full dose ☐ yes, partial dose ☐ no
4. Amniotic fluid colour: volume: odour:
5. Placental weight ☐ >500 g ☐ <500 g
6. Mechanism of delivery ☐ spontaneous/induced ☐ caesarean section ☐ instrumental delivery
7. Foetal position:

HbA1c – glycated haemoglobin, g – gram

Gastrointestinal anomalies were 2.75 times more common in preterm infants, which were predominant in our study. In our study, we prenatally detected only 23.5% of congenital malformations of the digestive system.

We also recorded congenital malformations of the urinary and genital system in 12 newborns (12.5%) from our study. In 8 newborns (8.3%) there was dilatation of the renal pelvis, of those, 4 cases were unilateral and 4 cases were bilateral. In 2 newborns (2.1%) were diagnosed with hydronephrosis, of them one case was unilateral and one case was bilateral and in 2 newborns unilateral ovarian cysts were found. One case (1%) was diagnosed with renal hypoplasia, megaureter, urinary bladder exstrophy, and ambiguous genitalia. Ray et al., in the results of their study describe the incidence of congenital malformations of urinary system in only 11 newborns (1.4%) out of a total of 792 children (Ray *et al.*, 2004). Defects of the urinary system may also be diagnosed prenatally, but often indirectly due to the presence of oligohydramnios (Saphier *et al.*, 2000). In our study only 21.4% of congenital malformations of the urinary and genital system were prenatally detected, and oligohydramnios was confirmed in only one case.

In our study, postnatal hypoglycaemia, which was measured immediately after birth, was confirmed in 22% of newborns, of which only 2% had clinical manifestations (hypotonia, drowsiness, convulsions). To achieve euglycaemia, intravenous glucose administration in 17 newborns was initiated, and early enteral intake with breast milk was initiated in 2 children. Mahmood and Kayes reported that hypoglycaemia was confirmed in 23% of newborns (12 newborns), of which 8 newborns were symptomatic (Mahmood & Kayes, 2008).

Other laboratory and haematological abnormalities that we observed were hypocalcaemia, which was confirmed in 12.5%, polyglobulia was detected in 6% and unconjugated hyperbilirubinaemia was found in 30% of newborns, of which in 21 newborns phototherapy was indicated. Similar results were published by Alam et al. whereas hypocalcaemia was in 15% and hyperbilirubinaemia was measured in 30% of newborns (Alam *et al.*, 2006). Opara et al. describes polyglobulia in 10.6% of newborns (Opara, Jaja, Onubogu, 2010). Ingale et al. reported up to 39% incidence of hyperbilirubinaemia, for which phototherapy was indicated (Ingale, Kakar, Karguppikar, 2017).

Conclusion

The essence of care for pregnant diabetics is based on intensive monitoring of the patient, multidisciplinary cooperation and adjustment of adequate diet and movement measures. A regular monitoring of diabetes and early detection of diabetic complications is also necessary because with sufficient preconception preparation with uncomplicated diabetes and optimal metabolic

Table 4b. Anamnestic and clinical data about newborn and mother with diabetes mellitus – Characteristics of the perinatal period (Gregáňová, 2020).

Characteristics of the perinatal period
Gestational age ☐ <37 g. w., pre-term birth ☐ ≥37–41 g. w., term birth ☐ ≥41 g. w., post-term birth
Apgar score 1st minute: 5th minute: 10th minute:
Resuscitation ☐ yes ☐ no
Birth trauma ☐ yes ☐ no
Asphyxia pH of umbilical cord blood: acid-base balance parameters pH: pCO_2: BE: HCO^{3-}: pO_2: asphyxia ☐ light ☐ moderate ☐ severe clinical neurological manifestations: multiorgan system dysfunction:
Birth weight:
Prenatal nutritional status (Phenton growth charts) ☐ hypotrophy ☐ eutrophy ☐ hypertrophy
Birth length:

g. w. – gestational week, pH – the negative logarithm of the hydrogen-ion concentration, pCO_2 – carbon dioxide partial pressure, BE – base excess, HCO^{3-} – bicarbonates, pO_2 – oxygen partial pressure

Table 4c. Anamnestic and clinical data about newborn and mother with diabetes mellitus – Complications of the newborn (Gregáňová, 2020).

Complications of the newborn
Respiratory system meconium aspiration ☐ yes ☐ no transitory tachypnoea ☐ yes ☐ no RDS ☐ yes ☐ no ☐ application of surfactant ☐ respiratory support pneumothorax ☐ yes ☐ no persistent neonatal pulmonary hypertension syndrome ☐ yes ☐ no other (congenital malformations, other diseases):
Cardiovascular system hypertrophic cardiomyopathy ☐ yes ☐ no ☐ without obstruction ☐ with obstruction persistent ductus arteriosus ☐ yes ☐ no other cardiac congenital malformations:
Alimentary system microcolon ☐ yes ☐ no
other congenital malformations:
Central nervous system intracranial bleeding ☐ yes ☐ no other congenital malformations:
Urogenital system congenital malformations:
Metabolic and haematological parameter hypoglycaemia: hypocalcaemia: polyglobulia: hyperbilirubinaemia: phototherapy ☐ yes ☐ no exchange transfusion ☐ yes ☐ no

RDS – respiratory distress syndrome

compensation throughout pregnancy, pregnant women have up to a 95% chance of giving birth to a healthy child (Hájek *et al.*, 2004; Borovský *et al.*, 2016).

Due to the fact that some congenital anomalies (e.g. anomalies of the urinary and genital system) may not be detected in the prenatal or neonatal period, it is recommended that children of diabetic mothers receive epidemiological surveillance in early childhood in specialized outpatient department (Ray *et al.*, 2004).

The obtained results were a source for creating a manual based on our findings. Our proposal of the manual is given in the Tables 4a–4c entitled "Anamnestic and clinical data about newborn and mother with diabetes mellitus". This manual is divided into 3 parts: Table 9a is about the mother´s characteristics, Table 9b describes characteristics of perinatal period and Table 9c informs about complications of the newborns. The proposal of the manual could help neonatologists or paediatrician in practice, to get a comprehensive picture of a newborn whose mother had diabetes mellitus during pregnancy and to get to know the patient better especially immediately after delivery as well as during postnatal phase of adaptation, and thus ensure her timely, prompt, and adequate management by focusing on possible associated complications.

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