Management of infants born to mothers with gestational diabetes. Paediatric environment

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Abstract

Objective: To evaluate the modalities of neonatal care for cases of treated and untreated gestational diabetes mellitus (GDM).

Methods: A search of the PubMed database was performed and recommendations from the National Institute for Health and Clinical Excellence and the French National Authority for Health were consulted.

Results: There were no paediatric indications for birth to take place in a specialised facility, except in cases of severe foetal growth abnormality, major malformations or risk of premature birth. Systematic blood glucose monitoring is recommended for newborns of mothers with insulin-treated GDM, or infants considered large or small for gestational age. Systematic blood glucose monitoring is not recommended for infants of mothers with diet-controlled GDM, or in the absence of growth abnormalities. Newborns should undergo routine neonatal icterus monitoring. Measurement of calcium levels and a complete blood count (CBC) should be carried out when clinically appropriate. Complementary testing for the detection of heart, bone or brain defects should be performed according to clinical signs. The indications for transferring infants of mothers with GDM to a neonatal intensive care unit are the same as for all other newborns.

Conclusions: Newborns can be cared for in general maternity wards, except in cases of premature birth, major malformations or severe foetal growth abnormalities. The management of newborns of mothers with GDM, particularly in the prevention, detection and management of hypoglycaemia, is improved through the existence of a written protocol.

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1. Materials and methods

The articles used for this chapter are those which were selected and analysed in chapter “Foetal and neonatal complications in gestational diabetes”.

The references from the chosen articles and from several other review articles were analysed in a search for additional relevant studies. Recommendations from the following learned societies were consulted: French National Authority for Health (Haute Autorité de santé: HAS) www.has-sante.fr/publications; National Institute for Health and Clinical Excellence (NICE) www.nice.org.uk. The references that were not found in the previous search were selected.

Only articles written in English or French were kept. The articles were classified by level of evidence as follows: meta-analyses, randomised controlled trials, non-randomised controlled trials, cohort studies. For any given chapter, the articles with the highest level of evidence were selected and discussed first.

When a given question could not be answered based on the references selected from 2000-2010, the most recent pre-2000 articles with the highest level of evidence were kept.

Additional research was conducted for the section dealing with hypoglycaemia. The bibliographic search was performed using PubMed by prioritising the studies published during the last ten years (January 2000 to April 2010). The following search terms were used: neonatal hypoglycaemia/management of neonatal hypoglycaemia.

2. Introduction

No previous study has specifically evaluated the outcome of infants born to diabetic mothers. Most data come from randomised or cohort studies. Only one cohort study has specifically dealt with this subject [1]. The National Collaborating Centre for Women’s and Children’s Health has published recommendations for the management of infants born to diabetic mothers, but fails to distinguish between GDM and gestational diabetes [2].

3. Determining the place of birth,

i.e. the neonatal maternity environment

In cases of GDM, the level of risk associated with birth can be foreseen by determining the type of maternity facility in which the infant will be born. The risks of neonatal morbidity in cases of untreated GDM have been reviewed (see “Foetal and neonatal complications in GDM” of this issue). The majority of these risks are rare and non-proven, except for macrosomia and its associated risks. Maternal obesity is a risk factor for independent perinatal complications and is commonly associated with GDM. The serious perinatal complications (malformations and perinatal deaths) reported in studies on GDM have been attributable to undiagnosed pre-pregnancy type 2 diabetes. No publications have specifically dealt with the choice of maternity facility for mothers with GDM, other than the recommendations published by the HAS in December 2009 concerning at-risk pregnancies and the choice of maternity facility for delivery [3].

One randomised study compared 490 women with diet-controlled or insulin-treated GDM (fasting plasma glucose maintained at < 1 g/L [5.5 mmol/L] and 2-hour postprandial blood glucose at < 1.26 g/L [7 mmol/L]), with 510 women receiving routine pregnancy care and no specific treatment for GDM [4]. The authors concluded that treatment of GDM reduces serious neonatal complications (death, shoulder dystocia, bone fracture and brachial plexus palsy) and the number of macrominute newborns. In the treatment group, there were no perinatal deaths (versus 5, p = 0.07), no obstetric traumas (versus one infant with humeral fracture and radial palsy, and 2 with brachial plexus injuries, p >0.05). The only severe complication observed was shoulder dystocia in 7 cases (versus 16 cases, p=0.08), but it did not lead to any other complications. An Apgar score < 7 at 5 minutes was recorded for 1% of infants (versus 2%, p = 0.26). The incidence of macrosomia (> 4,000 g) was 10% (versus 21%, p < 0.001), and 13% of infants were large for gestational age (LGA) at term (versus 22%, p < 0.001). Seven percent of infants of mothers in the treatment group presented hypoglycaemia requiring intravenous glucose (versus 5%, p = 0.16). Five percent of newborns had respiratory distress syndrome (RDS), defined by the need for supplemental oxygen beyond 4 hours after birth (versus 4%, p = 0.15). Although there were no differences between the two groups in terms of the incidence of an Apgar score < 7 at 5 min, hypoglycaemia, convulsions and RDS, the newborns in the treatment group were more frequently admitted to the neonatal intensive care unit (NICU) (71 versus 61%, RR = 1.13 [1.01-1.23], p = 0.01) (EL1).

Another randomised study evaluated the benefits of treating moderate GDM, defined by a fasting plasma glucose < 0.95 g/L (5.3 mmol/L) and two or three timed glucose measurements following a 100 g OGGT exceeding 1.80 g/L (10.0 mmol/L) at 1-hour, 1.55 g/L (8.6 mmol/L) at 2-hours and 1.40 g/L (7.8 mmol/L) at 3-hours [5]. During follow-up, the women in the treatment group (n=485) received insulin or diet therapy if the majority of fasting plasma glucose values were >0.95 g/L (5.3 mmol/L), or their 2-hour postprandial blood glucose was >1.20 g/L (6.7 mmol/L). The control group (n=473) received routine pregnancy care. The mean BMI of the women in the treatment group was 30.1 ± 5.0 kg/m², which was similar to the control group (50% obese, 34% overweight and 16% normal weight). The authors concluded that the treatment benefits for newborns were a reduced risk of macrosomia >4,000 g (5.9 versus 14.3, RR = 0.41 [0.26-0.66], p < 0.001) and shoulder dystocia (1.5 versus 4%, RR = 0.37 [0.14-0.97], p=0.02). No deaths were recorded in either group, and there were 3 cases of obstetric trauma (brachial plexus palsy, bone fracture) in the treatment group (versus 6 in the control group). The incidence of hypoglycaemia in the treatment group, defined by blood glucose < 0.35 g/L (1.9 mmol/L) in the two hours after birth or preprandial was 16.3%, and 5.3% of the infants in this group needed intravenous glucose. In the control group,
15.4% of newborns were hypoglycaemic and 6.8% were treated intravenously. In the treatment group, the rate of premature birth was 9.4% (versus 11.6%, p = 0.27), the rate of RDS was 1.9% (versus 2.9%, p = 0.33), and the rate of admission to NICU was 9% (versus 11.6%, p = 0.19) (EL1).

The majority of neonatal complications in mothers with treated GDM are rare. The most common events are macrosomia, shoulder dystocia and hypoglycaemia. Shoulder dystocia in itself is not a serious event. Among the obstetric traumas that can be associated, bone fractures and brachial plexus injuries do not usually require emergency specialised treatment. The two randomised studies that have evaluated the incidence of hypoglycaemia in infants born to mothers with treated versus non-treated GDM found that intravenous therapy was required in 5 to 7% of cases. Hypoglycaemia can therefore be monitored and treated in the majority of cases in all types of maternity facilities, as long as a protocol exists for the diagnosis and management of neonatal hypoglycaemia. Such protocols can be established by professionals in the perinatal network (see the recommendations from the “Sécurité Naissance-Naitre Ensemble” network in the Pays de Loire region, France).

The recommendations published by the HAS in December 2009 concerning at-risk pregnancies and the choice of maternity facility for delivery, state that specialised care is not necessary for women with GDM and that the place of delivery must be adapted to the estimated foetal weight and term of pregnancy [3].

**Conclusion**

There are no paediatric indications for childbirth to take place in a specialised facility, except in the following cases:
- risk of premature birth;
- major malformations affecting the vital prognosis from birth and/or requiring immediate specialised care;
- severe foetal growth abnormality, large or small for gestational age evaluated by estimated foetal weight and reported to the gestational age.

The logistical organisation (technical, competence and organisational requirements) of maternity wards caring for pregnant women must allow for the monitoring and management of hypoglycaemic attacks and other complications in infants born to diabetic mothers. Thus infants with normal growth born to mothers with insulin-treated or diet-controlled GDM can be cared for on general maternity wards.

**4. Screening and management of hypoglycaemia**

**4.1. Which newborns should be screened?**

The incidence of hypoglycaemia in cases of GDM varies between studies. The exact incidence remains difficult to assess because of the heterogeneity of the definitions in the different studies.

In the two randomised studies evaluating the effects of specific versus routine treatment for GDM, the incidence of hypoglycaemia treated intravenously varied from 5 to 7%, with no significant differences related to the treatment method used for the diabetes (see “Foetal and neonatal complications in GDM” of this issue) [4, 5] (EL1).

A single-centre cohort study based on data gathered from a hospital database between 1994 and 1996 included 530 infants born to diabetic mothers, of which 332 had GDM (249 diet-controlled only, defined as class A1 GDM, and 103 insulin-treated defined as class A2 GDM). The type of population and the prevalence of diabetes were not reported. This study described the clinical outcome of newborns [1]. Hypoglycaemia was defined as mild if serum glucose was between 0.30 and 0.39 g/L (1.7-2.2 mmol/L), moderate between 0.20 and 0.29 g/L (1.1-1.6 mmol/L) and severe if less than 0.2 g/L (1.1 mmol/L). Blood glucose levels were measured in 514/530 infants. One or several hypoglycaemic episodes were recorded for 137/514 newborns (27%). These episodes were mild, moderate or severe, each type making up one third of the total. The incidence of hypoglycaemia was 23% for class A1 diabetes and 24% for class A2 diabetes. The incidence of each type of hypoglycaemia was not specified. The rates of hypoglycaemia in these two groups were high. However, the postnatal age at the time of diagnosis was not given. Infants born before 34 weeks’ gestation (WG) accounted for 30 of the 137 cases of hypoglycaemia, there were 55 cases of LGA and two cases of small for gestational age (SGA). Therefore an associated risk factor was present in 87/137 patients (63.5%) with hypoglycaemia. The infants born to mothers with GDM were only transferred to NICU if they were born before 34 WG, or if they were suffering from RDS or major malformations. Out of the 173 infants assigned to routine care, 5 of those born to mothers with A1 GDM (2.8%), and 7/44 (16%) of those born to mothers with A2 GDM, required subsequent admission due to hypoglycaemia. The analysis after logistic regression adjusted for the type of diabetes showed that transfer from routine care to NICU was less frequent for breast-fed infants. The growth characteristics of the infants subsequently hospitalised for hypoglycaemia were not specified, but 22 of the infants later admitted due to hypoglycaemia and/or RDS were born between 34 and 36 WG (EL4).

Macrosomia associated with GDM increases the risk of hypoglycaemia. In a cohort study of over 36,000 singleton pregnancies in women with GDM, there was a higher risk of hypoglycaemia in newborns with a birth weight > 4,000 g, compared to those with a birth weight of less than 4,000 g (OR=2.6 [1.05-6.45]) [6]. However, the incidence of hypoglycaemia (defined as blood glucose < 0.35 g/L [1.95 mmol/L] or plasma glucose < 0.40 g/L [2.2 mmol/L]) was relatively low in both groups (2.6% and 5.3% respectively, p = 0.04) (EL2).
Conclusion

- The risk of severe hypoglycaemia is low in cases of both treated and non-treated GDM (EL1).
- There is a greater risk of transfer to NICU for insulin-treated diabetic mothers (EL4).
- Macrosomia increases the risk of hypoglycaemia (EL2).

4.2. When should screening be performed for hypoglycaemia?

There is an immediate fall in blood glucose concentration after birth, reaching a nadir between 1 and 2 hours in healthy term infants. From 3 hours of age, blood glucose then rises spontaneously, even in the absence of any nutritional intake, due to the activation of metabolic pathways. Therefore, blood glucose concentration should not be measured in infants less than 3 hours old since normal levels cannot be distinguished from abnormal levels during this period [7]. Measurement at this stage does not allow for the activation of the physiological systems that regulate blood glucose to be evaluated. The first blood glucose measurement is sometimes recommended after the second feed, which generally allows infants who cannot manage adequate early glucose homoeostasis to be identified [7]. A meta-analysis based on six publications which reported blood glucose values in newborns attempted to define the 5th percentile of blood glucose concentrations during the first 72 hours of life. The majority of the studies analysed were of healthy term infants, with no growth abnormalities, and 35% of which were breast-fed. Based on the measurements of 291 subjects, the 5th percentile of blood glucose value in the 1 to 2 hour postnatal period was 28 mg/dL (1.54 mmol/L) [8] (N2).

If blood glucose is measured too early on, the incidence of hypoglycaemia is likely to be overestimated. In the study by Landon et al., which found the incidence of hypoglycaemia (a value < 0.35 g/L [1.9 mmol/L]) to be between 15 and 16%, blood glucose was measured during the first two hours after birth and before feeding [5].

The different metabolic pathways involved in glucose regulation are activated during the first 24 hours of life [9]. Thus, in theory, at-risk infants who have not presented hypoglycaemia during the first 24 hours, have been fed normally, and whose clinical state has not changed, do not present a higher risk of subsequent hypoglycaemia.

4.3. What is the blood glucose concentration threshold for hypoglycaemia?

Hypoglycaemia is by definition a low level of glucose in the blood. The difficulty arises when establishing a threshold blood glucose concentration below which there is a likelihood of long- or short-term damage to the newborn, particularly from a neurological perspective. In newborns, hypoglycaemia can therefore be considered as the threshold value below which brain energy metabolism cannot be sustained. It is difficult to establish a definition because different approaches can be considered [7].

In the epidemiological approach, hypoglycaemia is considered as a value lower than two standard deviations below the mean. This statistical definition does not take into account the clinical situation of the infant, in particular the feeding method (breast- or bottle-feeding), nor does it consider the metabolic situation (alternative substrates such as lactate and ketone bodies). The clinical approach, based on the presence of signs like apnoea, hypotonia, jitteriness, apathy, hypothermia, tremors and seizures, has not been adapted. The clinical signs are non-specific and some of them are very common in healthy newborns (tremors). There is no correlation between blood glucose concentration and clinical signs in newborns. The neurological signs associated with hypoglycaemia are the result of a deficient energy supply to the brain. There are very often no clinical signs of low blood glucose values.

The neurophysiological and neurodevelopmental approaches appear to be valid, but are in fact no longer useful. Auditory and somatosensory evoked potential abnormalities have been found for blood glucose values < 0.45 g (2.6 mmol/L). However, in the respective study, only 17 patients were included and alternative substrates were not measured [10] (EL4). These results have been refuted by another study which analysed auditory-evoked potential (AEP) response in 27 full-term and 23 premature newborns according to blood glucose concentration. No correlation was found between blood glucose values between 0.25 and 1.23 g/L (1.38-6.83 mmol/L) and AEP response [11] (EL4). An association has been found between blood glucose levels < 0.45 g/L (2.6 mmol/L) and a low Bayley score at 18 months [12] (EL4). This correlation was not identified between the ages of 7 and 8 [13].

The complexity of the energy metabolism means that it is difficult to determine the blood glucose threshold for ensuring sufficient energy supply to the brain. Glucose is an essential energy substrate for the brain, but other substrates can be used, such as lactate and ketone bodies. The consequences of low blood glucose levels depend on the availability of these other substrates which are not routinely measured, and whose threshold values are unknown. The availability of these substrates also depends on the clinical and nutritional state of the infant. This is why a strict definition of hypoglycaemia does not seem to be applicable. In this context, operational thresholds have been suggested according to the clinical state of the newborn. [14]. These thresholds do not correspond to a definition of abnormal blood glucose levels; they establish safe thresholds for guiding clinical intervention. For infants presenting clinical signs associated with hypoglycaemia (see What is the blood glucose threshold for hypoglycaemia? of this issue), treatment must ensure that blood glucose levels remain above 0.45 g/L (2.5 mmol/L). If symptoms persist despite adapted treatment, other causes should be investigated since the symptoms are not specific. For newborns presenting
4.4. How should blood glucose be measured?

The use of a glucometer and reagent strips after capillary puncture is a common method for whole blood glucose measurement in NICU due to its convenience, low cost and rapidity. However, this method is neither reliable nor consistent, and its sensitivity and specificity are considered insufficient. Reagent strips were initially developed for self-monitoring by diabetic subjects, and were validated for normal and high blood glucose measurements. They are therefore not ideally adapted for screening for neonatal hypoglycaemia. There is an additional risk of measurement error associated with the high hematocrit levels in newborns compared to adults, and the use of skin-cleansing agents (the presence of alcohol lowers results). At present, there is no method that is sufficiently reliable and consistent to be used to screen for neonatal hypoglycaemia [15].

The gold standard method for the measurement of blood glucose is to collect samples in fluoride tubes (tubes containing sodium fluoride, which inhibits glycolytic enzymes), which are then laboratory tested. This method is more restrictive because it requires laboratory access and extra time to transport samples and gather results. In addition, venous puncture is required.

It is therefore necessary to find a compromise between the two solutions. It is advisable to choose a glucometer according to its reliability for high hematocrit levels, and to check its calibration at regular intervals. For hypoglycaemia cases, laboratory testing of fluoride tube samples should be performed, but therapeutic measures should be initiated without waiting for the results. For prolonged monitoring, a laboratory standard plasma or serum measurement once or twice a day is preferable to frequent reagent strip-based estimations [7].

4.5. Monitoring and treatment indications

- Newborns should be fed as soon as possible after birth (30 minutes) and then at regular intervals (every 2-3 hours).
  - Infants should be kept with their mothers,
  - Skin-to-skin contact and early breast contact (first half hour) should be encouraged,
  - Breast-feeding should be promoted (metabolic benefits of maternal milk on ketogenesis and brain energy substrates),
  - Non breastfed infants should have their first feed within the first 30 minutes.
- In the absence of clinical signs, blood glucose monitoring should not commence until after the 1st feed and just before the 2nd.
- Blood glucose monitoring is recommended for infants born to mothers with insulin-treated GDM or newborns with a birth weight >90th percentile.
- In this group of newborns, regular feeds should enable a preprandial blood glucose concentration above 0.36 g/L (2.0 mmol/L) to be maintained.
- Earlier blood glucose monitoring is recommended in the presence of clinical signs.
- Blood glucose monitoring should not be performed by a regularly calibrated reading device well-adapted to the characteristics of the infant; hypoglycaemia detected with reagent strips should be confirmed by laboratory testing.
- When blood glucose is < 0.36 g/L (2 mmol/L) in two consecutive tests despite maximal support for feeding, if there are abnormal clinical signs or the newborn is not feeding orally effectively, additional measures such as enteral tube feeding or intravenous 10% glucose should be given.
- Infants presenting clinical signs of hypoglycaemia should have their blood glucose reliably tested and be treated with intravenous dextrose as soon as possible.
- Systematic blood glucose monitoring should not be carried out for infants of mothers with diet-controlled GDM only, or newborns with a birth weight between the 10th and 90th percentile.
- Infants of mothers with GDM and whose weight is below the 10th percentile should undergo systematic blood glucose monitoring under the same conditions as macrosomic newborns.
- The detection and management of hypoglycaemia are facilitated by the existence of a written protocol (Appendix 1).

5. Other care options for asymptomatic infants at birth

5.1. Icterus monitoring, screening for hypocalcaemia and polyglobulia

The incidence of hyperbilirubinemia and the use of phototherapy is not higher in cases of GDM (see “Foetal and neonatal complications in GDM” of this chapter) [4, 5] (EL1). In the cohort study the Cordero et al., 6% of full-term infants of diabetic mothers (all types) underwent phototherapy, whereas during the same period, 5% of full-term infants born to nondiabetic mothers were treated with phototherapy [1] (EL4).

No study has specifically investigated the risk of hypocalcaemia in cases of GDM. In the study by Cordero et al., three infants out of the 332 (<1%) born to mothers with A1 or A2 GDM presented hypocalcaemia (total calcium level < 1.5 mmol/L or ionised calcium level < 1.00 mmol/L) [1] (EL4).

The risk of polyglobulia (haematocrit >65%) has not been evaluated in randomised studies comparing treatment...
versus no treatment of GDM. This has been evaluated, however, in two recent studies comparing a series of treated and non-treated patients. In the retrospective case-control study by Langer et al., which included 555 women with untreated GDM (diagnosed after 37 WG), 1,110 women with treated diabetes (diagnosed at two intervals, 50 and 100 g of glucose according to the criteria of Carpenter-Coustan) and 1,110 nondiabetic women, the incidence of polyglobulia was higher in the untreated group (13%) compared to the other two groups (2.2% and 1.4% respectively). The OR for the treatment versus control group was 10.88 (6.16-19.18) [16] (EL4). However, the clinical outcomes were not reported.

In the study by Ostlund et al., 213 women with untreated glucose intolerance (GI) were prospectively included from 1997-2001 [17]. GI was defined by fasting plasma glucose < 1.2 g/L (6.7 mmol/L) and 2hr blood glucose after 75 g OGTT between 1.6 and 2.0 g/L (9 and 11.0 mmol/L). For every glucose intolerant woman included, four control subjects were recruited at the same centre (n=812). There was no difference between the two groups for incidence of polyglobulia requiring treatment (0.2% in the control group versus 1.0% in the GI group) (EL2).

In the study by Cordero et al., hematocrit levels were assessed in 52% (276/530) of infants. Among these, 13 (5%) had a hematocrit level >65%. Three were treated with partial exchange transfusion and had RDS. The type of maternal diabetes was not specified [1] (EL4).

### Monitoring and treatment modalities
- **Newborns should undergo routine neonatal icterus monitoring.** Measurement of bilirubin levels should be performed when clinically appropriate.
- **Measurement of calcium levels should be performed when clinically appropriate.**
- **A CBC to detect polyglobulia should be performed when clinically appropriate.**

#### 5.2. Indications for morphological evaluation

The risk of malformations in cases of GDM is discussed under “Foetal and neonatal complications in GDM” of this issue. The conclusions are as follows:

- The risk of malformations moderately increases in mothers with GDM compared to the general population (EL2).
- The increased risk of malformations is probably linked to the presence of undiagnosed type 2 diabetes among the patients with GDM (EL2).
- There is a link between the risk of malformations, the level of maternal blood glucose, age at the time of GDM diagnosis and maternal obesity (EL2).
- The malformations described in GDM cases are analogous to those reported in pregestational diabetes (cardiac, skeletal and brain defects) (EL2).

Concerning hypertrophic cardiomyopathy, the lack of data in the literature means that it is not possible to estimate the incidence and exact risks in cases of GDM, or to evaluate the link with maternal blood glucose level (see “Obstetric monitoring in gestational diabetes mellitus and specific treatment for the threat of premature delivery”).

Neonatal screening must therefore be oriented towards cardiac, skeletal and brain defects. According to the recommendations of the National Collaborating Centre for Women’s and Children’s Health for the screening of Cardiac defects in cases of maternal diabetes, a cardiac ultrasound should be performed in the presence of clinical signs associated with congenital heart malformations (cyanosis, murmur) or cardiomyopathy (heart failure) [2].

There are no studies or recommendations on screening for vertebral and cerebral birth defects in cases of GDM. It is not always possible to identify vertebral anomalies like hemivertebra in antenatal ultrasonography or at the neonatal clinical assessment. The risk is considered to be greater in cases of abnormal maternal blood glucose levels during the periconceptual period. This only concerns infants born to mothers with type 2 diabetes undiagnosed before pregnancy. This situation is particularly common in obese women or when diabetes is difficult to treat during pregnancy and requires insulin. Other skeletal anomalies, particularly sacrum defects, can be identified on clinical evaluation, which should guide the prescription of complementary testing (sacrum and spine x-ray, medullary ultrasonography).

Transfontanellar ultrasound should be used to detect brain defects when clinically appropriate.

#### Conclusions

**Complementary testing for heart, bone or brain defects should be carried out according to the signs on clinical examination.**

### 6. Indications for transfer to NICU

Serious neonatal complications, particularly problems with adaptation to extraterine life, whatever the cause, are rarely associated with GDM. A strategy using antenatal corticosteroids for foetal maturation is discussed in “Obstetric monitoring in gestational diabetes mellitus and specific treatment for the threat of premature delivery”, and in “Foetal and neonatal complications in GDM” of this issue. Corticosteroids should be used before 34 WG in accordance with the recognised indications, but there are no recommendations in the literature for their use in the later stages of pregnancy. Infants born to mothers with GDM should not be systematically transferred to NICU. The transfer indications are the same as for all other newborns. The National Collaborating Centre for Women’s and Children’s Health has issued a set of recommendations on this subject [2]. The specific indications for the transfer of infants born to diabetic mothers are as follows:

- RDS:
- perinatal asphyxia with signs of encephalopathy (evaluate indications for therapeutic hypothermia);
identification of a malformation requiring immediate specialised treatment;
- signs of heart failure linked to heart defect or hypertrophic cardiomyopathy;
- symptomatic hypoglycaemia or requiring IV infusion and/or enteral tube feeding;
- severe and/or symptomatic hypocalcaemia requiring IV calcium infusion;
- symptomatic polyglobulia or requiring exchange transfusion;
- severe icterus requiring prolonged phototherapy and regular bilirubin monitoring;
- premature birth < 34 WG or < 36 WG depending on the treatment options on the maternity ward.

Specific cases of obstetric trauma (fracture, brachial plexus lesion):

There are no recommendations for the specific treatment of bone fractures or brachial plexus injuries during the immediate neonatal period.

Bone fractures are suspected at birth, or diagnosed during the first days through palpation of the area concerned or the presence of painful and functional (humerus) signs. The diagnosis is confirmed by x-ray of the area affected. There is no specific treatment for fractures. A simple analgesic is given and the area concerned is carefully manipulated.

In the very first few days, brachial plexus injuries require the arm to be immobilised by tucking the elbow into the body. An x-ray should be performed for the detection of clavicle or humeral fractures. Pain medication should be given. Other complementary tests and transfer are not indicated. Accurate muscle testing should be carried out during the first week of life in order to describe the initial injury. No specific treatment should be initiated during the neonatal period.

Conclusions

- The indications for transferring the newborns of mothers with GDM to NICU are the same as for every other newborn.
- Newborns with a fracture or brachial plexus injury should not be transferred to a specialised facility during the first few days of life.

7. Conclusions

- Serious neonatal complications in infants born to mothers with GDM are rare.
- Birth can take place on a general maternity ward, except in cases of premature birth, major malformations or severe foetal growth abnormalities.
- All maternity wards should have a written protocol in place for the screening and management of hypoglycaemia in infants born to diabetic mothers.
- These protocols should be distributed within perinatal networks in order to standardise practices.

8. Conflict of interests

No conflict of interest related to the article.

9. Appendix 1: Decision-making elements and management of neonatal hypoglycaemia

- Monitoring of infants born to mothers with insulin-treated GDM or newborns with a birth weight >90th percentile or < 10th percentile:
  - The first measurement of capillary blood glucose should be made before the second feed and every three hours thereafter, before feeds, for asymptomatic
newborns.
- In the presence of clinical signs, blood glucose monitoring should be performed earlier on, and at any time when clinical signs are observed.
- If two consecutive measurements ≥ 0.45 g/L (2.5 mmol/L) are made, measurements should continue every six hours.
- Measurements should stop after 24 hours if blood glucose values are normal and nutritional intake is stable.

**Blood glucose < 0.36 g/L (2 mmol/L) over two consecutive measurements and newborn is asymptomatic with optimum nutrition every 2-3 hours:**
- Nutrition should be enriched in stages as follows:

  *The use of lipids is based on physiopathological data: they stimulate neoglucogenesis and provide alternative substrates such as ketone bodies which are used by the brain.

**Blood glucose ≤ 0.36 g/L (2 mmol/L) and poor feeding:**

<table>
<thead>
<tr>
<th>Breasfeeding</th>
<th>Bottle feeding</th>
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<tbody>
<tr>
<td>Stage 1</td>
<td>2% fat-enriched milk formula*</td>
</tr>
<tr>
<td>Stage 2</td>
<td>2% fat and 2% carbohydrate-enriched milk formula</td>
</tr>
<tr>
<td>Stage 3</td>
<td>2% fat and 3 to 4% carbohydrate-enriched milk formula</td>
</tr>
<tr>
<td>Stage 4</td>
<td>Enteral feeding with 2% fat-and 3 to 4% carbohydrate-enriched milk formula and/or 10% serum glucose infusion</td>
</tr>
<tr>
<td>Stage 5</td>
<td>Enteral feeding with breast or formula milk 2% fat-and 3 to 4% carbohydrate-enriched milk formula and/or 10% serum glucose infusion</td>
</tr>
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- Enteral gastric-tube feeding: one feed every 3 hours administered over 1 hour.
- If blood glucose remains ≤ 0.36 g/L (2 mmol/L), it is possible to:
  - Increase the nutrition administration time (2 h/3 then continuous 3 h/3)
  - Enrich nutrition according to the stages described above
- If blood glucose remains ≤ 0.36 g/L (2 mmol/L) or if digestive tolerance is poor:
  - 10% glucose infusion exclusively or as supplement to enteral supply.

**Blood glucose ≤ 0.2 g/L (1.1 mmol/L) or clinical signs are present:**
- Peripheral venous catheter and administration of a bolus of 2 mL/kg of 10% glucose, followed by continuous infusion of 80 mL/kg/day of 10% glucose.
- Try to maintain supplementary enteral feeding or begin it as soon as possible.
- If enteral feeding is not possible, supply amino acids and lipids intravenously.

**Main principles to be respected for the management of hypoglycaemia:**
- The correction of hypoglycaemia involves the use of glucose but also proteins (or amino acids) and lipids in order to stimulate all the metabolic pathways that produce glucose.
- Enteral feeding should be given priority wherever possible.
- The measures implemented should be monitored by blood glucose measurements every 30 minutes to one hour according to the severity of the hypoglycaemia.
- It is advisable to return to the previous stage of feeding when blood glucose has been stable for 24 hours and to monitor blood glucose 3 to 6 hours after the change.
- In cases of enteral feeding, the return to oral feeding should occur simultaneously to the reduction of the enrichment of nutrition in order to stimulate oral sensations.