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Management of Diabetes in the Intrapartum and Postpartum Patient

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Abstract

Achieving maternal euglycemia in women with pregestational and gestational diabetes mellitus is critical to decreasing the risk of neonatal hypoglycemia, as maternal blood glucose levels around the time of delivery are directly related to the risk of hypoglycemia in the neonate. Many institutions use continuous insulin and glucose infusions during the intrapartum period, although practices are widely variable. At Northwestern Memorial Hospital, the "Management of the Perinatal Patient with Diabetes" policy and protocol was developed to improve consistency of management while also allowing individualization appropriate for the patient's specific diabetic needs. This protocol introduced standardized algorithms based on maternal insulin requirements to drive real-time maternal glucose control during labor as well as provided guidelines for postpartum glycemic control. This manuscript describes the development and implementation of this protocol to encourage other institutions to adopt a standardized protocol that allows highly individualized intrapartum care to women with diabetes.

Keywords

diabetes; intrapartum; postpartum; neonatal hypoglycemia

Goals of Intrapartum Care for Women with Diabetes

Maternal hyperglycemia in women with pregestational and gestational diabetes mellitus can cause hypoglycemia in the neonate following delivery.[1] Neonatal hypoglycemia occurs in up to half of infants born to mothers with pregestational diabetes,[2] and between 5 and 20% of women with gestational diabetes.[2,3] Neonatal hypoglycemia is a leading cause of admission to the neonatal intensive care unit, especially in premature or early term neonates,[4]

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Conflict of Interest

None.

increasing costs and separating mothers from their infants. Further, severe neonatal hypoglycemia can lead to seizures and other long-term neurological sequalae.[5]

For these reasons, decreasing maternal hyperglycemia during the intrapartum period is imperative to decrease the risk of neonatal hypoglycemia, as maternal blood glucose levels around the time of delivery are directly related to the risk of hypoglycemia in the neonate.[6] Further complicating intrapartum diabetes management is the competing goal of avoiding maternal hypoglycemia and ketosis, especially in women with type 1 diabetes mellitus, in a setting where women are often kept from eating and drinking by mouth. Maternal insulin needs decrease following delivery,[1,7] often leading to maternal hypoglycemia in the immediate postpartum period. Additionally, maternal hyperglycemia in the postpartum period can complicate recovery, particularly for patients recovering from cesarean deliveries. Thus, maintaining maternal euglycemia during labor, delivery, and the postpartum period is important for both maternal and neonatal health.

Development of an Intrapartum Diabetes Management Protocol

While the central goal of intrapartum maternal euglycemia has long been recognized, there remains no nationwide or international consensus on the best way to achieve this goal, and most national endocrine and obstetric governing bodies have not published specific guidelines. Many institutions use continuous insulin and glucose infusions during the intrapartum period, although the evidence base for doing so is not well established.[8] The American College of Obstetricians and Gynecologists (ACOG) recommends using a continuous insulin infusion to maintain blood glucose levels at rv100 mg/dL using a protocol adapted from Coustan,[1,9] but this protocol has not been universally adopted, and does not allow for different approaches for women with different degrees of insulin resistance. Moreover, based on our experiences and discussions with providers at other institutions, it is clear that practice varies widely from institution to institution.

Prior to protocol implementation, the method of medical management for women with pregestational and gestational diabetes mellitus at Northwestern Memorial Hospital's Prentice Women's Hospital, a large tertiary care center affiliated with the Northwestern University Feinberg School of Medicine, had been at the direction of a team of endocrinologists for over 30 years. During the intrapartum period, every 2 hours capillary blood glucose measurements were reported by registered nurses to the endocrinologists on call for insulin and dextrose titration for the laboring patient. Simultaneously, patients were managed from an obstetric standpoint by maternal-fetal medicine and/or general obstetricians. This approach was cumbersome and inefficient. Thus, there was the desire to develop a more systematic method for the medical management of diabetes during intrapartum care. Through a team approach of nursing leaders, endocrinologists, and obstetricians, a new policy, the "Management of the Perinatal Patient with Diabetes" protocol, was born.

The aim of the "Management of the Perinatal Patient with Diabetes" policy and protocol described herein was to improve consistency of management while also allowing individualization appropriate for the patient's specific diabetic needs. The protocol

introduced standardized algorithms to drive real-time maternal glucose control during labor as well as provided guidelines for postpartum glycemic control. Algorithms were created to allow the registered nurse to make insulin and/or dextrose changes immediately in response to the change in hourly capillary blood glucose measurements, thus improving the timeliness of pharmacologic administration. Prior to implementation, registered nursing staff went through extensive training on the care of women with diabetes in labor and the manual use of the insulin tables. In addition, all attending obstetricians and residents attended education sessions to review the new policy and the protocol. Complete implementation of the intrapartum management of diabetes with the new protocol took place in 2011.

The advantages of the Northwestern protocol include frequent blood glucose monitoring, an iterative approach to insulin and glucose infusions, and the ability to titrate insulin at different rates depending on antepartum insulin resistance and baseline insulin needs. Women who have diet-controlled gestational diabetes or gestational/type 2 diabetes treated with only low doses of insulin are often able to be euglycemic without mandatory insulin infusions. Thus, this protocol allows for both “watchful waiting” and for the ability to start insulin and up-titrate insulin quickly as needed. Additionally, a major advantage of this detailed protocol is the standardization of care at an institution that performs rv12,000 deliveries a year by rv140 attending physicians and midwives, 51 residents and fellows, and hundreds of nurses. The protocol has substantially diminished the between-provider variation in practices regarding intrapartum insulin and diminishes reliance on endocrinology input during labor. It also enhances efficiency of decision making and patient care, while also improving patient safety and consistency of care. Finally, an additional major advantage is that the protocol is sufficiently detailed that even a new resident or nurse has the ability to care for a woman with diabetes.

Disadvantages of this protocol have been its relative complexity and intensiveness when glucose levels may be decreasing or increasing on an hourly basis, and requiring two registered nurses always to double check the accurate dose of insulin administration.

Implementation

In the Northwestern protocol, the labor target maternal glucose range is 70 to 100mg/dL, which avoids both maternal hypoglycemia and remains below the recommended ACOG maximum intrapartum blood glucose of 110 mg/dL, a target designed for optimal neonatal outcomes.[1,10] The protocol advises initial care steps upon admission of the patient values (Fig. 1). The protocol additionally provides information about intravenous access for patients with diabetes, such as insulin requiring its own line, the appropriate priming of tubing for insulin, and use of insulin alongside appropriate dextrose-containing solutions. Regarding capillary blood glucose measurements, the protocol dictates performing an initial glucose check with subsequent hourly or q2 hour checks based on the patient’s type of diabetes and current results.

Insulin is then administered according to a series of tables that indicate the action in response to a capillary blood glucose measurement (Fig. 2). The choice of the “Table” to be used depends on the patient’s total daily dose of insulin as an outpatient. Women with ::: 60

units/24 hours of insulin will be on “Table 1,” including those with no insulin requirement, whereas women with 61 to 120 units, 121 to 180 units, and ;:: 180 units will be on Tables 2, 3, and 4, respectively. After each hourly glucose check, the table provides instructions on whether the insulin infusion is to be increased, decreased, or kept stable depending on the patient’s insulin resistance. Similarly, the table also instructs providers on the insulin administration, depending on the patient’s cumulative basal and bolus insulin requirements. When the Tables are used, patients with type 1 diabetes are never provided insulin levels of 0 units; when euglycemic, type 1 diabetes patients continue to be provided a low rate of insulin administered concurrently with dextrose to ensure basal insulin administration. Alternatively, for patients who strongly prefer use of their subcutaneous pump, the protocol includes a “Table 5” for management of subcutaneous pump changes. When the pump is utilized in labor, the patient must work together with the registered nurse to make changes to the pump settings based on the protocol-determined calculated changes. Patients are informed that should they be unable to participate in pump management (such as due to pain or emergency situations), their pump will be disabled and their insulin management will switch to IV insulin.

Additionally, the protocol includes a bedside nursing worksheet for documentation of the hourly capillary blood glucose values, rate of D10 infusion, if an insulin bolus was given and how much, and the amount of change in the basal insulin based on the appropriate Table (Fig. 3). The nursing worksheet serves as a safety check by requiring two nurses to check each calculation and change; glucose values and insulin changes are also recorded in the electronic medical record.

Postpartum Care

Immediately after delivery, postpartum insulin requirements decrease dramatically as a result of the rapid decrease in diabetogenic placental hormone levels and resulting dissipation of pregnancy-induced insulin resistance.[11] The Northwestern policy includes general guidance on postpartum diabetes management. Our general practices are summarized below.

Our policy specifies that women with type 1 or type 2 diabetes who require ongoing insulin administration should decrease insulin doses and undergo monitoring of preprandial blood glucose values while on the postpartum unit. Glycemic targets approximating nonpregnant targets are utilized.[12] Among women with type 1 diabetes, insulin requirements typically return to prepregnancy levels or lower following delivery. Women are typically advised to decrease basal and prandial insulin doses to 50 to 80% of their preconception doses, but recommendations are individualized. If preconception insulin doses are not known, one-third to one-half of the term pregnancy dose or weight-based dosing may be used as a starting point.[13] Among women with type 2 diabetes, postpartum medication requirements vary depending on the severity of hyperglycemia postpartum and the prepregnancy diabetes therapeutic regimen, ranging from no medical therapy to resumption of insulin therapy at reduced doses (as above) or noninsulin therapies following delivery.

Women with gestational diabetes discontinue insulin and a fasting glucose level is measured on postpartum day 1. A 2-hour 75-g oral glucose tolerance test is performed in the early postpartum period (4–12 weeks following delivery).[14]

Conclusion

Introduction of the "Management of the Perinatal Patient with Diabetes" intrapartum insulin protocol at Northwestern Memorial Hospital has greatly standardized the management of women with pregestational and gestational diabetes mellitus. The protocol has substantial benefits to providers by reducing errors and variability in obstetric management, as well as decreasing the need for intrapartum endocrinology or maternal-fetal medicine consults. Ultimately, while we believe we have been successful in standardizing insulin and glucose management during labor, the next steps are to evaluate how this protocol impacts maternal euglycemia in the reduction of neonatal hypoglycemia and how an algorithmic protocol compares to a "one-size-fits-all" protocol. We share our protocol to encourage other institutions to adopt a standardized protocol and evaluate its effect on clinical outcomes.

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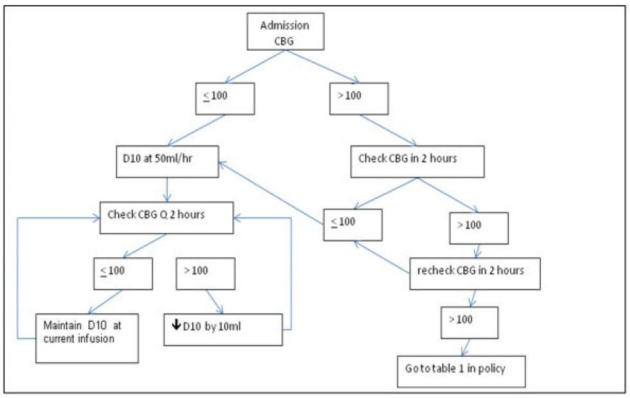
I. Admission process
   A. Assess diabetic history, including:
      1. Type of Diabetes (Type 1,2 or GDM)
      2. Outpatient insulin regimen
         a) Type (Novolog, Humalog, NPH, Lantus or other)
         b) Time and Amount delivered daily(eg. 5 units Novolog before each meal and 20 units of NPH at bedtime)
      3. Time of last meal or snack
      4. Last insulin administration including type, dosage and time
      5. Current CBG
   B. Notify MFM attending/fellow and antepartum resident of admission

II. Diabetes management for optimal glucose control
   A. Monitor CBG every hour with hospital meter while patient is in labor.
   B. **Management of Pre-existing Diabetes (T1 or T2) with IV glucose and/or insulin infusion**
      1. Two IV lines are required as mainline if insulin is required.
         a) Begin Lactated Ringers solution for mainline of all other medications e.g. Pitocin, antibiotics, Magnesium sulfate, D_{10})
         b) Begin infusion of 0.9 normal saline as mainline for insulin piggyback at a rate of 25mL/hr. Insulin infusion guidelines
      2. Insulin must have its own intravenous line
         a) No other medication, e.g. oxytocin, magnesium, antibiotics, D_{10}, etc. may share the insulin primary line.
         b) Regular Insulin infusion is prepared by the pharmacy in a concentration of 1 Unit = 1 mL
      3. Prior to the administration of the insulin infusion, the tubing used for the insulin infusion must be primed with 20ml of the insulin solution to saturate binding sites on the plastic tubing. The priming procedure must be repeated any time the tubing is changed.
      4. The insulin is programmed through the pump and piggybacked into the closest port to the IV access point.
      5. IV insulin dosage and addition of Dextrose 10% solution ($D_{10}W$) is dependent upon CBG values
         a) Insulin will be given as a bolus dose and continuous (basal) dose via the hospital approved infusion pump or patient's continuous subcutaneous infusion pump
            (1) If the patient has taken insulin (the previous evening NPH or Lantus) or eaten in the last 3-4 hours, monitor CBG hourly **without** giving IV glucose or insulin until necessary based on the table.
         b) Tables 1- 5 (See Appendix C) are to be used for women with T1 and possibly T2 diabetes in labor.
            (1) The patient's outpatient total daily dose (TDD) of insulin will determine which Table (1, 2 , 3 or 4) will be used for glucose and insulin management during labor. The physician will determine which table will be used.
            (2) Once the TDD table is determined, the initial CBG will be used to determine the appropriate initial IV insulin bolus, continuous basal insulin and/or D10W infusion
            (3) Hourly CBG results will drive the change of rate (decreasing, unchanged or increasing) in insulin and/or dextrose infusions until delivery.
      6. The worksheet included in Appendix D will be used by the nurse to keep track of dosage changes. This worksheet is not part of the medical record.
      7. Endocrinology may be consulted in the management of insulin infusion during labor.

C. **Management with Pre-existing Diabetes (T1 or T2) with patient's own subcutaneous insulin pump**
   1. One IV line of Lactated Ringers solution is required for mainline to allow for administration of medications (e.g. Pitocin, antibiotics, Magnesium sulfate, $D_{10}W$)
   2. No immediate changes may be necessary to the basal amount while in early labor.
   3. Changes to the insulin basal rate are based upon the CBG value. See Table 5 in Appendix C.

D. **Management of the Patient with Gestational Diabetes Mellitus (GDM A1 or A2) Diet controlled, oral hypoglycemic agent or insulin requiring**
   1. Start mainline IV fluids of LR at rate determined by physician.
   2. Women with GDM rarely are treated with insulin during labor.
   3. CBG will be assessed on admission and decisions made based on the following algorithm:



   4. The worksheet included in Appendix D will be used for GDM patients

E. **Care of the patient during immediate recovery Vaginal or Cesarean delivery (up to 2 hours post delivery):**
   1. Type 1 diabetes
      a) Reduce Basal IV insulin by 50%.
      b) Continue LR and continue $D_{10}W$ at 50cc/hr. if infusing.
      c) Check CBG hourly while in recovery
      d) Notify the managing physician if CBG result is < 70 or ≥ 200
      e) Breastfeeding is encouraged
   2. Type 2 or gestational diabetes
      a) Reduce IV insulin by 50% or discontinue if CBG within the normal range. IV insulin will be discontinued prior to transfer to postpartum.
      b) Check CBG hourly while in recovery
      c) Notify the managing physician if CBG result is < 70 or ≥ 200
      d) Breastfeeding is encouraged

Fig. 1.
Algorithm for care of the laboring patient

***Table 1*:**
Total Daily Dose of Insulin ≤ 60 Units/24 hours

Hourly	Initial Dose of Insulin		Continuous infusion	CBG UNCHANGED or INCREASING		CBG DECREASING	
CBG Mg/dL	Bolus Units IV push	Basal Units/hour	**D_{10} W ml/hr**	Bolus Units IV push	Basal Units/hour	Bolus Units IV push	Basal Units/hour
<70*	0	0	**50**	0	0	0	↓0.5
70-100	0	0	**50**	0	no△	0	↓0.3
101-130	1	0.5	**50**	1	↑0.5	0	no△
131-160	2	0.5	**50**	2	↑0.5	0	↑0.5
161-190	3	0.5	**0**	3	↑0.7	1	↑0.5
191-220	4	0.5	**0**	4	↑0.7	2	↑0.8
>220	5	0.5	**0**	5	↑0.8	3	↑0.8

* If CBG is < 70, give 100mL of $D_{10}W$ over 10 minutes followed by the 50mL/hr continuous infusion

***Table 2*:**
Total Daily Dose of Insulin 61-120 Units/24 hours

Hourly	Initial Dose of Insulin		Continuous infusion	CBG UNCHANGED or INCREASING		CBG DECREASING	
CBG Mg/dL	Bolus Units IV push	Basal Units/hour	**D_{10} W ml/hr**	Bolus Units IV push	Basal Units/hour	Bolus Units IV push	Basal Units/hour
<70*	0	0	**50**	0	0	0	↓0.4
70-100	0	0	**50**	0	no△	0	↓0.4
101-130	2	1.0	**50**	2	↑0.6	0	no△
131-160	3	1.0	**50**	3	↑0.6	0	↑0.6
161-190	4	1.0	**0**	3	↑0.8	2	↑0.6
191-220	5	1.0	**0**	5	↑0.8	3	↑0.8
>220	6	1.0	**0**	6	↑1.0	4	↑0.8

* If CBG is < 70, give 100mL of $D_{10}W$ over 10 minutes followed by the 50mL/hr continuous infusion

***Table 3*:**
Total Daily Dose of Insulin 121-180 Units/24 hours

Hourly	Initial Dose of Insulin		Continuous infusion	CBG UNCHANGED or INCREASING		CBG DECREASING	
CBG Mg/dL	Bolus Units IV push	Basal Units/hour	D_{10} W ml/hr	Bolus Units IV push	Basal Units/hour	Bolus Units IV push	Basal Units/hour
<70*	0	0	50	0	0	0	↓ 0.8
70-100	0	0	50	0	no△	0	↓ 0.5
101-130	3	1.5	50	3	↑ 0.8	0	no△
131-160	4	1.5	50	4	↑ 0.8	0	↑ 0.8
161-190	5	1.5	0	4	↑ 1.0	3	↑ 0.8
191-220	6	1.5	0	6	↑ 1.0	4	↑ 1.0
>220	7	1.5	0	7	↑ 1.2	5	↑ 1.0

* If CBG is < 70, give 100mL of $D_{10}W$ over 10 minutes followed by the 50mL/hr continuous infusion

***Table 4*:**
Total Daily Dose of Insulin >180 Units/24 hours

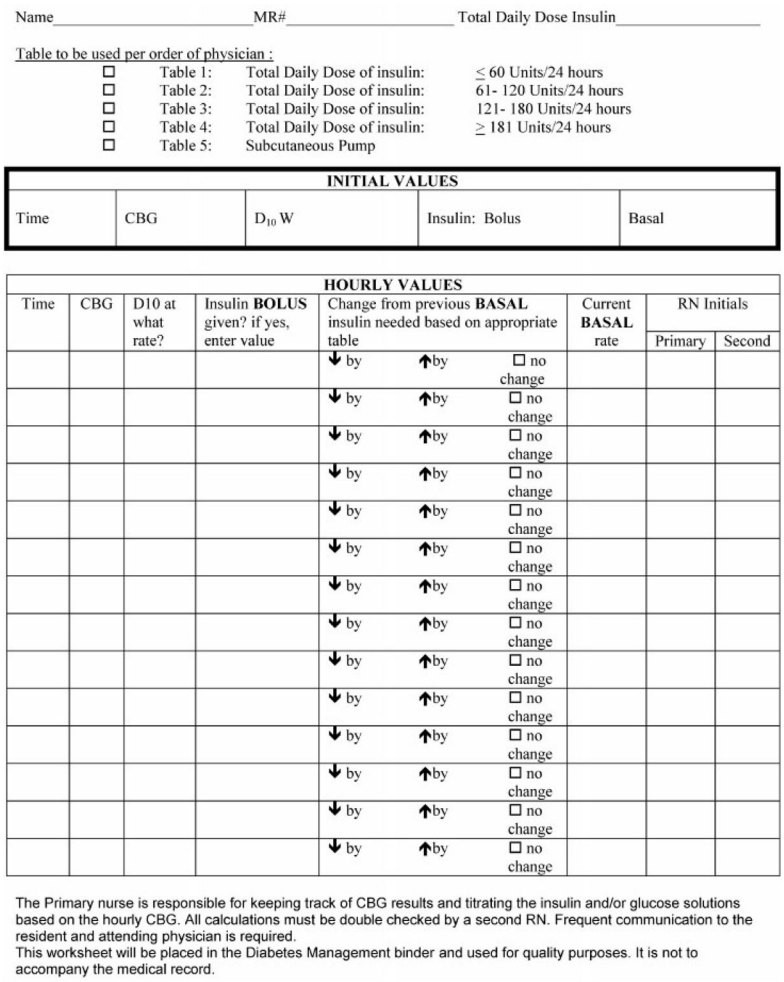
Hourly	Initial Dose of Insulin		Continuous infusion	CBG UNCHANGED or INCREASING		CBG DECREASING	
CBG Mg/dL	Bolus Units IV push	Basal Units/hour	D_{10} W ml/hr	Bolus Units IV push	Basal	Bolus Units IV push	Basal Units IV push
<70*	0	0	50	0	0	0	↓ 1.0
70-100	0	0	50	0	no△	0	↓ 0.6
101-130	4	2.0	50	4	↑ 1.0	0	no△
131-160	5	2.0	50	5	↑ 1.0	0	↑ 1.0
161-190	6	2.0	0	5	↑ 1.2	4	↑ 1.0
191-220	7	2.0	0	7	↑ 1.2	5	↑ 1.2
>220	8	2.0	0	8	↑ 1.6	6	↑ 1.2

* If CBG is < 70, give 100mL of $D_{10}W$ over 10 minutes followed by the 50mL/hr continuous infusion

TABLE 5: Glucose and Insulin Infusion when using continuous subcutaneous insulin pump

CBG Mg/dL	Glucose D10W	Insulin Basal rate	Comment
<70	100 ml/10 minutes	↓ 20%	Example: 1.2 U↓ 0.96U
70-100	50 ml/hr	no△	
101-150	0	↑ 20%	Example: 1.0 U↑ to 1.2U
> 150	0	Notify MFM	

Fig. 2.
Glucose and insulin infusion tables



Name_____MR#_____ Total Daily Dose Insulin_____

Table to be used per order of physician :

☐	Table 1:	Total Daily Dose of insulin:	≤ 60 Units/24 hours
☐	Table 2:	Total Daily Dose of insulin:	61- 120 Units/24 hours
☐	Table 3:	Total Daily Dose of insulin:	121- 180 Units/24 hours
☐	Table 4:	Total Daily Dose of insulin:	≥ 181 Units/24 hours
☐	Table 5:	Subcutaneous Pump	

INITIAL VALUES				
Time	CBG	D_{10} W	Insulin: Bolus	Basal

HOURLY VALUES								
Time	CBG	D10 at what rate?	Insulin **BOLUS** given? if yes, enter value	Change from previous **BASAL** insulin needed based on appropriate table			Current **BASAL** rate	RN Initials
								Primary / Second
				↓ by	↑by	☐ no change		
				↓ by	↑by	☐ no change		
				↓ by	↑by	☐ no change		
				↓ by	↑by	☐ no change		
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				↓ by	↑by	☐ no change		
				↓ by	↑by	☐ no change		

The Primary nurse is responsible for keeping track of CBG results and titrating the insulin and/or glucose solutions based on the hourly CBG. All calculations must be double checked by a second RN. Frequent communication to the resident and attending physician is required.
This worksheet will be placed in the Diabetes Management binder and used for quality purposes. It is not to accompany the medical record.

Fig. 3.
Worksheet for labor management of insulin and dextrose