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ABM Clinical Protocol #27: Breastfeeding an Infant or Young Child with Insulin-Dependent Diabetes

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A central goal of The Academy of Breastfeeding Medicine is the development of clinical protocols for managing common medical problems that may impact breastfeeding success. These protocols serve only as guidelines for the care of breastfeeding mothers and infants and do not delineate an exclusive course of treatment or serve as standards of medical care. Variations in treatment may be appropriate according to the needs of an individual patient.

Purpose

To provide guidance for the care of breastfeeding infants or young children with insulin-dependent diabetes mellitus (called diabetes in this protocol) and their families, describing:

1. The basis of insulin dosing for carbohydrate intake for breastfeeding infants
2. The basis of assessing the amount of carbohydrate for expressed breast milk
3. Insulin dosing in infants who have the style of small volume, frequent feeds
4. Goals and methods for glycemic control in breastfeeding infants and young children with diabetes
5. Guidance on counseling parents of breastfeeding infants and young children with diabetes, addressing the guilt associated with poor glycemic control and providing support to continue breastfeeding after diagnosis

Background

Breastfeeding provides ideal infant nutrition and is the physiologic norm for mothers and children.[1,2] Families with infants or young children with diabetes may wish to breastfeed but struggle with the challenges of glycemic control in the setting of unpredictable feeding quantities and patterns. Following the diagnosis of diabetes in their infant or young child, families often infer that they should not continue to breastfeed because of these challenges.[3]

This frequently occurs despite the evidence of maternal and child health benefits of human milk and breastfeeding.[4] The incidence of type 1 diabetes has been rising overall, with about 4% of patients being diagnosed younger than the age of 2 years in one Finnish study.[5] It is important to note that diabetes diagnosed in neonates and young infants is more likely to be of the monogenic form[a] (usually diagnosed before 9 months of age)[6] rather than the autoimmune type 1 diabetes seen in older infants and children, and management of these infants can be different.[7] For the purpose of treatment of diabetes requiring insulin, the same principles are used for both types of diabetes in infants.

Principles of Management

The goal of management of diabetes in the pediatric population is to maintain blood glucose levels within a target range with the least amount of variability to prevent complications of both hypo- and hyperglycemia. Achieving that goal in a very young child is challenging regardless of whether they are breast- or formula-fed, even for the most diligent caregivers. This is, in part, attributable to the continuously changing feeding needs and patterns of infants and young children.

Conventionally, caregivers are instructed to perform capillary (finger stick) glucose levels in young children before meals and snacks, occasionally after meals, at bedtime, and before exercise in older children, when they suspect low blood glucose and after treating low blood glucose until they are normoglycemic (6–10 times/day).[8]

In addition, caregivers are instructed to give insulin for all meals and snacks containing more than 10–15 g of carbohydrates

[a]Monogenic diabetes is caused by a single gene variant, and includes neonatal diabetes and Maturity Onset Diabetes of the Young (MODY). Although insulin is often used for the treatment of monogenic forms of diabetes, occasionally oral sulfonylureas are used after initial diagnosis and stabilization. In addition, infants with neonatal diabetes often have multiple other organ systems impacted, including severe neurologic manifestations making breastfeeding more difficult to initiate at birth. Expressed breast milk is an excellent alternative to breastfeeding in these rare cases.

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or for blood glucose levels outside of a target range (typically >14 mmol/L [250 mg/dL]) via injection or insulin pump. Total daily insulin requirements are mainly determined by weight and in conjunction with the family and the diabetes team. To mimic the normative patterns of pancreatic insulin secretion, total insulin requirements for patients with type 1 diabetes are divided into two parts: basal insulin and insulin for blood glucose level corrections. Both intermediate (insulin isophane or human neutral protamine Hagedorn [NPH]) and long acting preparations (insulin detemir and insulin glargine) are used to cover the basal insulin component. Intermediate insulin preparations are characterized by having a peak of action about 4–6 hours after the injection is given. This peak can be used to cover a meal or snack within that time period while that carbohydrate consumption is necessary to prevent hypoglycemia associated with the peak. Long acting insulin preparations, on the contrary, lack that peak of action, providing more flexibility with meal times and carrying a smaller risk of hypoglycemia.[9] Despite being widely used in clinical practice for children younger than 6 years of age, insulin detemir and glargine are not approved by the U.S. Food and Drug Administration in children younger than 6 years. They are, however, approved by the European Medicines Agency for children older than 2 years of age.

About a half (insulin detemir and insulin glargine) to two thirds (NPH) of the total insulin requirements are usually covered by the basal preparations. The rest of those requirements are given in the form of a short (rapid)-acting insulin (insulin aspart, lispro, or glulisine) to be given before meals and large snacks and for corrections of elevated blood glucose values. Families are usually provided with calculations or scales that can be used to determine short-acting insulin doses based on blood glucose level (insulin sensitivity factor) and the carbohydrates consumed by the child (carbohydrate ratio). An alternative management method is by continuous subcutaneous insulin infusion (insulin pump) that uses only short-acting insulin. The pump delivers insulin both as a continuous infusion replacing basal insulin and as boluses based on the same principles discussed above. In addition, families can be taught how to dilute insulin for administration via syringe or pump to provide more precise doses of insulin.

Perhaps the most challenging part of insulin dosing in infants and young children with diabetes is the calculation of the amount of carbohydrate consumed. This is, in part, due to the normal variability in appetite and food intake at this age. In infants consuming significant breast milk volumes, it is important for the clinician and family to attempt to quantify the breast milk intake and the carbohydrate content, when possible, for optimum insulin dosing.

Carbohydrate content of breast milk

Coppa et al.[10] previously observed that the lactose content in breast milk increased from 56 ± 6 g/L on day 4 of lactation to 68.9 ± 8 g/L on day 120. Given that most infants with Type 1 diabetes are diagnosed beyond the age of 6 months, using a carbohydrate count of 70 g/L would be applicable to most infants. Those carbohydrates are predominantly in the form of lactose, although there are several other oligosaccharides that contribute insignificantly to carbohydrate counts. Therefore, 100 mL of breast milk would contain ~7 g of carbohydrate.

Carbohydrate content of breast milk compared with commercial infant formulas

The predominant carbohydrate found in cow's milk-based infant formulas is lactose. The content is roughly equivalent to that of breast milk (70 g/L). What differs substantially between infant formulas and breast milk is the fat content. Infant formulas have an average of about 10 g/L less fat than that of equivalent volumes of breast milk.[11] This may be an important consideration as fat modulates the absorption rate of glucose into the bloodstream. Therefore, though not formally studied yet, one might conjecture that infants consuming breast milk have a more steady and mild postprandial glycemic variability than infants consuming infant formula.

Quantifying consumed breast milk

In the case of the infants provided with expressed breast milk or donor human milk, the calculations of carbohydrate content can be used to determine the required insulin dose. When the infant is breastfeeding, utilizing normative data for quantities of breast milk produced in a 24-hour period and dividing by the average number of breastfeeds would work well for most mother–infant dyads (Table 1). The average volume of breast milk produced in 24 hours across ages 7–12 months is about 740 mL (Table 2). This is on an average 52 g of lactose in 24 hours. Therefore, a 7-month-old infant who is breastfeeding six times a day would consume ~8.5 g of carbohydrate per breastfeed.[12] Alternatively, a 12-month-old infant breastfeeding three times a day may consume 8.5–17 g per breastfeed if it continues to consume ~740 mL per day. A more recently performed study of infants of younger ages (1–6 months) demonstrates similar breast milk production in a 24-hour period as noted in the prior study; infants fed on an average of 11 ± 3 times in 24 hours (range of 6–18) consuming 76 ± 12.6 mL each feed with a range of 0–240 mL.[13] It was noted that there tended to be higher volumes in the morning feedings compared with the evening feedings, and there was often a discrepancy in production between the left and right breasts.[13] Parents should be encouraged to notice if there are particular patterns to the carbohydrate estimates resulting in hyper- or hypoglycemia after breastfeeding and adjust their estimates accordingly as the aforementioned factors may be the cause rather than physiologic variation in insulin sensitivity.

These rough calculations may not be applicable for infants who have small volume frequent feeds rather than consuming more discrete ''meals'' at regular intervals. In this case, it is important to keep in mind that most blood glucose

Table 1. Summary of Methods of Estimating Carbohydrate Intake

Method of carbohydrate calculation	*Formula to derive grams of carbohydrate intake*
Average breast milk volume in 24 hours @ 70 g/L of carbohydrate/number of feeds (for 7–12-month-old infants)	52 g lactose/number of feeds in 24 hours = x g carbohydrate per feed (estimated)
Pre- and postfeed weight calculation	Weight in grams = mL of milk intake × 7 g/100 mL = x g of carbohydrate consumption (estimated)

Table 2. Average Milk Volumes/Day of Well-Nourished Women Who Exclusively Breastfed Their Infants

			Months of lactation											
			<1		*1–2*		*2–3*		*3–4*		*4–5*		*5–6*	
Country	*No. days measured*	*Sex*	n	*mL/ 24 hour*	n	*mL/ 24 hour*	n	*mL/ 24 hour*	n	*mL/ 24 hour*	n	*mL/ 24 hour*	n	*mL/ 24 hour*
United States	2	M, F	—	—	3	691	5	655	3	750	—	—	—	—
United States	1–2	M, F	46	681	—	—	—	—	—	—	—	—	—	—
Canada	?	M, F	—	—	—	—	—	—	33	793	31	856	28	925
Sweden	?	M, F	15	558	11	724	12	752	—	—	—	—	—	—
United States	3	M, F	—	—	11	600	—	—	2	833	—	—	3	682
United States	3	M, F	—	—	26	606	26	601	20	626	—	—	—	—
United Kingdom	4	M, F	—	—	27	791	23	820	18	829	5	790	1	922
		F	—	—	20	677	17	742	14	775	6	814	4	838
United States	1	M, F	16	673 ± 192	19	756 ± 170	16	782 ± 172	13	810 ± 142	11	805 ± 117	11	896 ± 122
Months of lactation				7		8		9		10		11		12
United States	1	M, F		875 ± 142		834 ± 99		774 ± 180		691 ± 233		516 ± 215		759 ± 28

Modified from Ferris and Jensen.[30] Reproduced with permission from Breastfeeding: A Guide to the Medical Profession, 7th ed.

measurements will reflect the postprandial state[14] and that infants tend to consume small, hard-to-measure amounts of nutrients that would require very small doses of insulin, which cannot be given with the delivery systems (syringes, pens) presently available. In this situation it may be more practical to measure the infant's capillary glucose level every 3 hours and give insulin for correction of blood glucose levels without measuring the infant's carbohydrate intake. However, the goal should be to use the conventional insulin dosing methods as soon as the child starts to consume food at regular intervals (meals).

Pre- and postfeed weights

Weighing the infant before and immediately after a breastfeed may provide a more precise calculation of breast milk volume and thus carbohydrate intake for determining insulin doses (Table 1). An accurate digital scale should be used. The difference in weight in grams between the two measurements equals the amount of milk ingested in milliliters. A simple calculation can then be performed given that there are ~7 g of carbohydrate in 100 mL of human milk. Families do not always have access to a digital scale, nor is it recommended as a daily method as it is burdensome for parents. However, obtaining pre- and postfeed measurements at well-child checks every 2–3 months, or performing this procedure over a 24-hour period every few months would allow for an approximation of the proper dose of insulin for a full feed. This is also a strategy that could be more easily used while the infant is being stabilized in hospital following the initial diagnosis to help establish the quantities consumed and fine-tune the insulin dose. Every effort should be made by the medical team to give the parents a message of support and acceptance that breastfeeding is the optimal form of nutrition for the infant.

Insulin pumps

The use of continuous subcutaneous insulin infusion (insulin pump) provides optimum insulin dosing in infants and young children with diabetes. Because of the factors mentioned above, the amount of insulin that infants need is sometimes very small. Insulin syringes with half unit markings are often used to deliver a dose as little as a half a unit. However, that may not be small enough in some cases. Insulin pumps, on the contrary, have the capability of delivering tenths to hundredths of a unit of insulin. The use of insulin pumps has been shown to improve the quality of life for families and infants, young children, and preschool children compared with multiple daily injections.[15] A systematic meta-analysis of six randomized control trials found better effectiveness of insulin pumps compared with multiple daily injection in improving metabolic control in children with type 1 diabetes mellitus.[16]

Solid foods

Older infants and young children are routinely offered solid foods that often comprise the majority of their carbohydrate consumption. At that time, quantifying carbohydrates in infrequent breastfeeding sessions may not be as important for improving glycemic control. Parents can estimate the carbohydrates in solid foods with or without breast milk with rounding the insulin dose to the nearest half unit.

The Impact of Hypo- and Hyperglycemia

The goal of management in infants and very young children with diabetes is to avoid frequent hypoglycemia associated with neurocognitive sequelae while also aiming to reduce sustained hyperglycemia.

Hypoglycemia

Early childhood is a critical time for growth and brain development. Studies have shown that exposure to hypoglycemia is associated with a decline in neurodevelopmental outcomes in children.[17,18] Very young children with diabetes are particularly at risk of severe hypoglycemia due to their small insulin requirements, marked sensitivity to exogenous insulin, variability in oral intake and inability to express symptoms of hypoglycemia. These factors create anxiety in both healthcare providers and the parents/caretakers who often tend to aim for higher glucose levels to avoid the detrimental

effects of hypoglycemia. In addition, the practice of postmeal dosing of insulin in the face of unpredictable amount of food ingested at meals, and the style of small volume frequent feeds results in higher blood glucose levels after meals.

Hyperglycemia

Regional changes noted in brain growth of very young children with diabetes suggest that hyperglycemia and perhaps glycemic variability also play a role in brain development.[19] Furthermore, while there is evidence to suggest that the progression toward microvascular complications begins with the onset of puberty, glycemic control in the first few years following the diagnosis of diabetes sets the risk pattern, a form of metabolic memory, and trajectory for an individual toward developing microvascular and macrovascular complications.[20] It has also been found that good glycemic control, even during the first few years following the diagnosis of diabetes, is associated with delay in microvascular complications, particularly diabetic retinopathy.[21,22]

Achieving the balance between good glycemic control and minimal hypoglycemic episodes would provide the best outcomes with regard to brain growth and neurocognitive function. This requires vigilance, collaboration, and support among the family, other caretakers, and the medical team.

Family Dynamics and the Importance of Breastfeeding

As in the general population, breastfeeding is superior to other forms of nutrition in infants and young children with diabetes. Families of those children should be provided with support and understanding from their medical team, which will foster lifelong collaboration toward the health of the child.

The stress of diagnosis and healthcare provider attitudes

Following the diagnosis of diabetes in their infant or young child, many parents feel tremendous guilt over abnormal blood glucose levels and find the intensive management of diabetes stressful. Mothers of infants and very young children who are breastfeeding at the time of diagnosis may perceive that healthcare providers are frustrated by the difficulty of quantifying carbohydrate intake from breastfeeds.[3] This adds to the psychological burden of the parents and also implies that breastfeeding is detrimental to the health of their child, which has no scientific basis. Although there is a lack of literature supporting improved outcomes for infants or young children with diabetes who were breastfed, there is good evidence that breastfeeding improves cognitive function, irrespective of socioeconomic status, and increases brain white matter development.[23,24]

Other benefits of breastfeeding

Breastfeeding represents the normative standard in infant feeding and nutrition,[4] and should be the recommended method of infant feeding in the case of diabetic infants as well. The benefits of breastfeeding in decreasing the risk of infections and hospitalizations,[25] decreasing the future risk of obesity,[26] and other chronic health outcomes in addition to improving bonding between mother and child may be especially beneficial in improving the health outcomes for children with diabetes. Infants who directly breastfeed instead of being bottle-fed expressed breast milk exhibit an increased ability to self-regulate their milk intake during late infancy.[27] The duration of breastfeeding demonstrates a potential link to satiety responsiveness in older children.[28] The ability to make healthy food choices later in life is likely to aid in achieving better glycemic control in adolescents and adults with diabetes.

Summary of the Recommendations

1. Breastfeeding is the optimal form of infant nutrition for infants and it should be promoted as such by healthcare providers for infants with diabetes.
2. When calculation of carbohydrate intake is utilized for insulin dosing, a carbohydrate count of 70 g/L can be used for breast milk. (IA) (Quality of evidence [levels of evidence IA, IB, IIA, IIB, III, and IV] is based on levels of evidence used for the National Guidelines Clearing House[29] and is noted in parentheses.)
3. The norms for 24-hour total volumes of breast milk can be used in determining the amount of breast milk consumed by the infant at a single feed. (IIB, IV)
4. For infants who have a small volume frequent style of food consumption, blood glucose levels should be measured every 3 hours and insulin doses given for correction of levels above the glycemic target. (IV)
5. When feasible, infant weights before and after a breastfeed can be used to determine the amount of milk usually consumed by the infant at each feed. (IV)
6. The use of continuous subcutaneous insulin infusion (insulin pumps) should be considered for infants and young children with diabetes as desired by their caregivers. (III)
7. Support should be provided to the families of infants and young children diagnosed with diabetes along with tailoring the diabetes management plan to the patterns of breastfeeding and the needs of the mother–infant dyad. (III/IV)

Recommendations for Future Research

The lack of information on the feeding trends and breastfeeding rates of infants and young children with type 1 diabetes is concerning. We, therefore, propose the following to begin to improve our understanding of breastfeeding infants or young children with diabetes:

1. There is a need for a prospective longitudinal database to track breastfeeding rates and monitor for outcomes of infants with diabetes. Existing databases such as T1D Exchange Registry or other comprehensive diabetes registries could be used to track this information and carry out studies. This would allow for the systematic evaluation of the preventative role of breastfeeding an infant with diabetes, as well as guide the management of diabetes in these infants. To our knowledge, there is currently no information being collected in the T1D Exchange or other diabetes registries with respect to breastfeeding.
2. Studies evaluating the feasibility and benefit of current technologies (insulin pumps and continuous glucose monitoring systems [CGMs]) in infants and young children with diabetes are needed. In the United States and European Union, CGMs are only approved for use in children older than 2 years of age. The use of these systems could potentially bring in-

sulin management closer to the goal of achieving the balance between the avoidance of hypoglycemia and achieving optimal glycemic control. In addition, it would allow the study of the glycemic profile differences of breast milk compared with infant formula in infants with diabetes.

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ABM protocols expire 5 years from the date of publication.

Content of this protocol is up-to-date at the time of publication. Evidence-based revisions are made within five years or sooner if there are significant changes in the evidence.

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