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An Evidence-Based Approach to Breastfeeding Neonates at Risk for Hypoglycemia

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ABSTRACT

The revised standard of care for breastfeeding infants at risk of developing hypoglycemia during transitioning to extrauterine life was developed using the American Academy of Pediatrics (AAP) 2011 hypoglycemia guidelines, the Academy of Breastfeeding Medicine protocol, and staff input. A pre/postimplementation chart audit indicated support of infant safety by glucose stabilization, breastfeeding within the first hour of life, and breastfeeding frequency without an increase in blood sampling, formula use, or admissions to the special care nursery.

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Hypoglycemia is one of the life threatening issues neonates face during transition to extrauterine life (Barnes-Powell, 2007). In utero, maternal glucose crosses the placenta, but insulin does not. Thus the fetus must produce insulin to maintain glucose homeostasis. Elevated or erratic maternal glucose levels ≥ 100 mg/dl during pregnancy can result in a hyperinsulinemic infant at birth (Hyperglycemia and Adverse Pregnancy Outcomes [HAPO] Study Cooperative Research Group, 2008). When the umbilical cord is cut, mobilization of infant glucose stores and/or nutritional support by feeding are required to mediate endogenous insulin. If glucose is not available, the infant becomes hypoglycemic, and the brain and other vital organs are depleted of glucose necessary to maintain homeostasis (Milicic, 2008). The American Academy of Pediatrics (AAP; 2011) recommended putting an infant to breast within the first hour of life to stabilize infant glucose.

In 2011, the AAP Committee on Fetus and Newborns published the first revision of the neonatal hypoglycemic guidelines since 1993 (AAP, 1993, 2011). This evidence-based practice guideline is a step toward standardization of treatment for neonatal hypoglycemia through the following steps: (a) identification of infants at risk, (b) assessment of blood glucose levels that require intervention, (c) treatment criteria with intravenous (IV) and/or oral nutrition, (d) frequency of blood glucose monitoring, and (e) delineation of neonatal symptoms of hypoglycemia. What constitutes neonatal hypoglycemia, the treatment modality, and subsequent sequelae have been controversial topics (Burns, Rutherford, Boardman, & Cowan, 2008; Hays, Raju, Higgins, Kalhan, & Devaskar, 2009; Straussman & Levitsky, 2010; Williams, 2005). Blood glucose levels used to define neonatal hypoglycemia ranged from a threshold of ≤ 25 to 50 mg/dl (Harris, Weston, Battin, & Harding, 2009; Hays et al., 2009; Williams, 2005). Treatment for an asymptomatic infant was debated, but all sources agreed that an infant that exhibited symptoms should be treated (Harris et al., 2009; Hays et al., 2009; Williams, 2005). Sequelae of neonatal hypoglycemia that have been assessed include neurological changes that could result in childhood seizure disorders and metabolic issues such as childhood metabolic syndrome (Boney, Verma, Tucker, & Vohr, 2005, Burns et al., 2008; Straussman & Levitsky, 2010).

Breast milk is the gold standard for infant nutrition. At birth, the gut is sterile and breast milk

In 2011, revision of the neonatal hypoglycemic guidelines by the American Academy of Pediatrics standardized definitions and treatment approaches to neonatal hypoglycemia.

assists in proliferation and colonization with Bifidobacteria and Lactobacilli through fermentation of nondigestible oligosaccharides to promote gut health (Walker, 2010). The AAP (2011) recommended proactive measures to stabilize infant glucose levels to minimize maternal/infant separation and to support breastfeeding success. Strausssman and Levitsky (2010) reported that infants born to diabetic mothers who were breastfed within 30 minutes of life had less hypoglycemia than infants who were fed later. Colostrum or lactogenesis I, the first breast milk produced at delivery, is known to be low in glucose and calories but stimulates ketone metabolism in the neonate, thus providing nutrition and promoting glucose stabilization (Wright, Marinelli, & The Academy of Breastfeeding Medicine Protocol Committee, 2006).

Breastfeeding is supported by state and international governmental agencies (New York State Department of Health [NYS DOH], 2011; World Health Organization [WHO], 2011), professional organizations (AAP, 2011), and lay organizations such as La Leche League. All of these organizations recommend that stable infants be managed by (a) initiation of breastfeeding within the first hour of life, (b) demand feedings with the mother and infant in close proximity, (c) avoidance of bottles or pacifiers, and (d) exclusive breastfeeding for at least 6 months. Maternal/infant contact is considered one of the best predictors for breastfeeding success (Hill & Aldag, 2007; NYS DOH, 2011; Nommsen-Rivers, Chantry, Peerson, Cohen, & Dewey, 2010; Rouwei, Fein, Chen, & Grummer-Strawn, 2008; WHO, 2011) and is accomplished through rooming-in, where the mother and infant stay in the same room. Admission to the special care nursery (SCN), newborn nursery, or a transitional care nursery creates a physical separation that interrupts the continuity of maternal/infant contact. The introduction of formula prior to establishment of an ample milk supply can have a detrimental effect on infants and mothers (Hill & Aldag, 2007; NYS DOH, 2011; Rouwei et al., 2008; WHO, 2011; Wright et al., 2006). For example, formula feeding early in the postpartum experience may inadvertently suggest to a mother that her milk is not sufficient to support her infant's nutrition (Hill & Aldag, 2007; Rouwei et al., 2008).

The Joint Commission (2010) and the NYS DOH (2011) require NYS hospitals to support exclusive breastfeeding to maintain credentialing and reimbursement status. The pathophysiology of neonatal hypoglycemia may preclude exclusive breastfeeding and require medical interventions, such as the use of formula and/or IV therapy. These interventions are classified as medically indicated and are described in the Academy of Breastfeeding Medicine (ABM) Clinical Protocol #1: Guidelines for Glucose Monitoring and Treatment of Hypoglycemia in Breastfed Neonates (Wright et al., 2006). This protocol is also used by the National Guidelines Clearinghouse for the treatment of neonatal hypoglycemia (Department of Health and Human Services, 2007). Additionally, maternal and neonatal healthcare providers are faced with substandard breastfeeding rates (Healthy People 2012), process changes required by regulatory agencies (The Joint Commission, 2010; NY DOH, 2011), and the need to implement evidence-based practice (AAP, 2011).

An assessment of practice at our institution indicated that the neonatal hypoglycemia standard of care (SOC) needed revision to comply with the AAP 2011 guidelines and the ABM protocol. The AAP guideline indicates that late-preterm or term infants who are large for gestation age (LGA), small for gestational age (SGA), or born to diabetic mothers are at risk for hypoglycemia. Glucose thresholds were set that vary depending upon infant age: (a) at birth to four hours of age the blood glucose should be $\geq$ 25 mg/dl and (b) at 4 to 24 hours of age the blood glucose should be $\geq$ 45 mg/dl. The AAP indicates that if the infant glucose levels drop below these thresholds intravenous (IV) therapy should be initiated. The existing SOC defined hypoglycemia as a blood glucose of $\leq$ 40 mg/dl for all infants at any age, but treatment varied according to hypoglycemia severity with a blood glucose of 20 to 39 mg/dl requiring a formula feeding and those $\leq$ 19 mg/dl requiring IV therapy. Infants identified as at risk included all of the AAP's categories plus infants of obese mothers, polycythemia, and multiple gestations. In addition, the Hypoglycemic Risk Tool was used to screen infants born to medication dependent diabetic mothers to determine if they should be admitted to SCN (Scheurer-Monaghan, Haidar-Ahmad, Lowmaster-Csont, & Guillet, 2009). The caloric content, amount, and mode of oral nutrition administration were not addressed by the AAP or the SOC guidelines. Furthermore, neither the AAP nor the SOC addressed when formula should be administered to breastfed infants or the time allotted for the infant to latch before formula intervention was required.

The goal of this process improvement project was to determine if a proactive, structured breastfeeding plan for infants at risk for developing hypoglycemia resulted in (a) stabilized infant blood glucose, (b) decreased formula feedings, (c) increased breastfeeding attempts, and (d) avoidance of SCN admission. Kotter's 8-step change model (1996) with an underpinning of staff involvement was used for this process improvement project.

Methods

Conceptual Framework

Kotter's 8-step change model is a tested and respected model for organizational change and strategic planning (Kotter & Whitehead, 2010). Staff involvement is indicated at each step. To optimize the change within an institution each step must be completed, preferably in sequential order, prior to moving to the next step. These steps include (a) creating a sense of urgency, (b) forming a powerful coalition, (c) creating a vision, (d) communicating the vision, (e) empowering others to act on the vision, (f) planning for and creating short-term wins, (g) consolidating improvements and producing still more change, and (h) institutionalizing new approaches (Kotter, 1996, p. 21). However, work on more than one step may occur simultaneously. The steps build upon each other in a logical manner based on increasing information and involvement from key stakeholders. The steps should not be viewed as a two-dimensional linear progression but rather as a spiral staircase with rapid cycling through the completed steps.

Setting

The institution is a 261- bed community hospital located in a medium- sized city in western New York. The Family Maternity Center (FMC) has 40 maternity beds with more than 3,000 deliveries annually; mothers delivering prior to 34 weeks gestation are transferred to a tertiary care center when feasible. There is an estimated equal distribution of private and public payers. Approximately 80% of mothers initiate breastfeeding in the hospital. Several factors facilitated implementation of the project in this setting, including (a) a large population of potential participants, (b) a collaborative multidisciplinary team that provides care to mothers and infants, (c) managerial support for implementation of evidence- based practice and best practice initiatives, (d) the change agent was a staff member with established relationships within the FMC, and (e) a current educational emphasis on fetal and infant glucose homeostasis. Conversely, there were barriers in this setting, including (a) multiple recent change initiatives, such as the implementation of the electronic medical record (EMR) and the creation of a new management structure; (b) staff's difficulty with adaptation to the new EMR that created inconsistent documentation; (c) nurse resistance to changing the status quo; and (d) institutional multilayer approval processes.

Project Design

We used a two-phase mixed-methods design. Phase I involved collection of staff input for development of a revised SOC to incorporate the culture of the FMC. The second phase was development, implementation, and evaluation of the revised SOC. Evaluation was conducted using a pre- and postintervention design to compare the safety and effectiveness outcomes under the revised SOC to outcomes under the prior SOC. Research Subjects Review Board approval was obtained for each phase of this project prior to implementation.

Phase I

A survey was developed to assess the current practice and identify deviations from the existing SOC. It was also used to assess staff satisfaction with and understanding of the current SOC, to serve as an educational tool regarding neonatal hypoglycemia, and to encourage staff input into the anticipated change process. Prior to implementation, the survey was piloted with a cross-section of 10 staff members that included managers, providers, and nurses. The results were analyzed using SPSS 17 and demonstrated a high level of internal consistency (Cronbach's alpha = .912). The finalized survey was administered electronically to the entire neonatal staff using Survey Monkey subsequent to an introductory e-mail that included a link to the AAP hypoglycemia guidelines (see Table 1). Staff members were asked to complete the survey within 3 weeks and a reminder notice was delivered 3 days prior to the end of the allotted time. All involved units and disciplines were represented.

Analysis. The results were compiled using Survey Monkey and reported as number of responses and means (see Tables 1 and 2).

Phase II

SOC Development. The revised SOC was developed using the information collected in Phase I

Table 1: Survey Questions/Results

1. I feel the current policy for treating neonatal hypoglycemia is clear in regards to:				
	True	False		
When to intervene	46	6		
What to feed	31	21		
Method used to feed	23	28		
Amount to feed	17	34		
2. Breastfeeding is the best way to stabilize an infant whose blood sugar is 20 to 39 mg/dl:				
	True	False		
	26	26		
3. After delivery, a term infant's blood glucose nadirs (reaches its lowest level) at:				
0–1 hr	1–2 hrs	2–4 hrs	4–8 hrs	8 hrs
5	33	12	3	0
4. Baby Boy C (BBC) was born via cesarean for fetal distress after 18 hours of labor to a gravida 1, para 0 to 1 mother with a prepregnant body mass index (BMI) of 34 and no other prenatal complications. Ms. C "hopes" to breastfeed. The baby's 1-hour blood glucose (BG) was 41 mg/dl and the 2-hour is now 29 mg/dl. Ms. C's cesarean is the 3rd of 5 for today and is ready to be transferred to the mother/baby unit. You would respond in the following manner:				
4a. How long would you attempt to get BBC to latch for breastfeeding?				
None, I would feed formula	0–5 min	6–15 min	15–30 min	As long as it takes
11	15	21	3	3
4b. What caloric formula would you feed BBC?				
None, I would only use breast milk	20 cal/oz	22 cal/oz	24 cal/oz	
6	33	12	2	
4c. When would you draw BBC's next blood glucose?				
30 min	1 hr	2 hr	3 hr	When the baby demands
43	10	0	0	0
4d. When BBC's blood gas is greater than ___ before two consecutive feedings, I know his hypoglycemia has resolved.				
20 mg/dl	30 mg/dl	40 mg/dl	50 mg/dl	60 mg/dl
0	0	40	12	1

and staff education was completed prior to implementation. Multidisciplinary leaders at all levels within the unit participated in the revisions. The Pediatric Clinical Service Quality Committee (CSQC), Nursing Unit Council, and the institutional Nursing Standards Committee were involved in the final approval and implementation process. This is reflective of Kotter's (1996) Steps 2 through 5 that emphasize staff involvement and empowerment.

The Pediatric CSQC, an interdisciplinary committee that represents nursing, medicine, and lactation leadership, approves changes within the pediatric clinical practice prior to implementation. This committee was provided with an initial draft of the revised SOC that included (a) differential treatment that followed the AAP 2011 algorithm, (b) specified time allotment to allow the infant to latch for breastfeeding prior to using formula, (c) use of expressed breast milk supplemented with formula to make 3 to 5 ml/Kg/feed (Wright et al., 2006) if the infant was unable to breastfeed, and (d) use of 20 caloric/ounce formula if breast milk was unavailable. The Pediatric CSQC provided recommendations for revisions and following revisions gave final approval. Once approval was obtained

Table 2: Demographics of Hospital Staff Survey Participants

		Sample ($N = 53$)		%			
Nurses		47					
– AD		14		31			
– Diploma		8		17			
– BS		19		41			
– MS		5		11			
NP		2					
CNM		2					
MD (pediatric)		2					
Ages							
– 16–25		1		2			
– 26–35		11		24			
– 36–45		5		11			
– 46–55		15		38			
– ≥ 56		14		30			
	Labor & Delivery	Lactation	Mother/Baby	SCN Staff	SCN Providers	Midwives	Totals
Surveys Distributed	47	4	45	20	10	8	134
Response rate (%)	38%	25%	31%	65%	50%	25%	39.5%

Note. AD = associate's degree; BS = bachelor's degree; MS = master's degree; NP = nurse practitioner; CNM = certified nurse-midwife; MD = physician; SCN = special care nursery.

at the unit level, the revised SOC was approved by the Nursing Standards Committee for implementation and then implemented. The Unit Council, representing the staff nurses, participated in the planning and execution of the proposed change.

Implementation of Revised SOC. The first step to implementation was staff education. The Pediatric CSQC recommended the Department of Education within the institution be consulted for the development of educational materials. Following consultation, a self-study packet was developed that included the AAP hypoglycemic practice guidelines, the revised SOC, and the algorithms associated with the SOC. A multiple choice test question bank was developed by the first author that focused on general and unit specific information. Each unit (labor & delivery, mother/baby, and SCN) had study packets with unit specific posttests. The nurses were responsible to complete the education module and return their completed tests with all correct answers to unit representatives prior to the SOC implementation. The educational phase was completed over a 4-week period, and compliance by all staff members was required.

The SOC educational materials were printed on bright green paper and served as visual reminders. Posters that included the algorithms and highlighted the major changes for that unit were placed in nursing stations. Two weeks prior to implementation, the algorithms were hung in each patient room with a banner reinforcing the implementation date. A pocket-sized snapshot of the changes to the hypoglycemia protocol in the SOC was created and made available to staff members. Resource people were identified to provide support throughout the implementation. Special care nursery and labor and delivery nurses and pediatric providers from each shift were identified and given one-on-one educational sessions to familiarize them with the SOC changes and the rationale behind the changes.

Project Evaluation. Evaluation was accomplished using a pre/postintervention design that included data collection from medical records of all at-risk infants born in two 4-week periods: 6 months prior to (January 20, 2012 – February 15, 2012), and after implementation of the revised SOC (July 15, 2012 – August 11, 2012). To select charts of all infants at risk for hypoglycemia during the selected time period the established criteria of the institution were used.

All charts from the designated times periods that included infants identified as LGA, SGA, preterm, polycythemic, intrauterine growth restricted (IUGR), and multiple gestations were abstracted. The Fenton Preterm Growth Curve at the 10th and 90th percentiles as defined by the institution was used to determine if the infant was SGA or LGA. Gestational age was assigned using the first trimester ultrasound for dating. If unavailable, prenatal dating was used unless there was a discrepancy of more than 2 weeks between the prenatal dating and the Ballard exam in which case Ballard results were used. Polycythemia was defined as a central spun hematocrit > 65%. Multiple gestation and IUGR were collected from prenatal records. The total number of recorded blood gases (BGs) until the infant had three consecutive BGs ≥ 45 mg/dl (AAP, 2011) was used to determine achievement of euglycemia. The total numbers of documented breastfeedings and/or formula feedings were collected from the EMR.

In addition, maternal factors that determined an infant to be at risk were diabetes and obesity. Charts of mothers with a prenatal diagnosis of gestational or pregestational diabetes were abstracted. If a mother was treated with medication during the pregnancy to control her blood glucose, the Hypoglycemic Risk Tool was used to determine if the infant required admission to SCN (Scheurer-Monaghan et al., 2009). Medical records of mothers with maternal obesity, defined as a prepregnant BMI ≥ 30 kg/m^2, were also abstracted.

Other variables that could affect the infant transition and stabilization were collected from medical records such as length of labor, which was calculated from hospital admission to delivery and reported to the nearest hour. Feeding method with prior children, if applicable, was collected from documentation of maternal self-report.

A total of 119 mother/infant couplets, 54 pre- and 65 postintervention, were identified, and their EMRs were abstracted. Data were collected by the author on a password-protected computer and entered into a database spreadsheet. The data were then imported into SPSS 17 for analysis.

Analysis. The demographic data were analyzed using frequencies, means, and *t* tests or chi squared to compare pre- and postintervention groups. To assess effectiveness and safety of the intervention the pre- and postintervention groups were compared using two-tailed *t* tests for continuous variables and chi squared for categorical variables of interest. Continuous variables included number of BG checks, formula feedings, and breast feedings per infant until blood glucose was stable. Categorical variables included breastfeeding prior to formula feeding, SCN admission, and IV fluid therapy for hypoglycemia.

Results

Phase I

The survey was distributed to a total of 132 staff involved in the care of breastfeeding infants at risk for hypoglycemia. The response rate of 39.5% (n = 53) was representative of all staff with the highest responders from Special Care nursing and medical providers, 65% and 50%, respectively (see Table 2). The education levels of the nursing staff consisted of 52% with a bachelor's degree or higher. Sixty-three percent of the staff were older than age 46 (see Table 2). When asked about the clarity of the current policy 88% felt that when to intervene was clear but what to feed, method used to feed, and amount to feed were not. When staff members were asked if breastfeeding was the best way to stabilize an infant with hypoglycemia as defined by the current policy, the responses were equally divided between *yes* and *no*. The majority of the staff who completed the survey (n = 36) indicated they would allow an infant up to 15 minutes to latch, would feed 20 calories/ounce formula (n = 33), and recognized monitoring parameters (see Table 1).

Phase II

The sample included a total of 119 mother/infant couplets with 53 in the preintervention group and 65 in the postintervention group. The data from the entire sample were examined for distributions, frequencies, means, and standard deviations (*SD*). This was followed by comparison of the pre- and postintervention groups on all collected variables using Student's *t*-test or chi squared. The maternal pre- and postgroups were similar with the exception of epidural anesthesia use: the postintervention group had a higher use of epidural anesthesia ($p < .05$) (see Table 1). The mean BMI for the entire sample was in the obese range (≥ 30 kg/m^2) and first time mothers accounted for the highest prevalence of obesity at 46% (see Table 3).

Table 3: Select Characteristics of Mothers who Delivered Infants at Risk for Hypoglycemia

	Total Sample Sample ($N = 119$)	Preintervention ($n = 54$)	Postintervention ($n = 65$)
Race			
White	79 (66.4%)	33 (61.1%)	46 (70.8%)
Black	23 (19.3%)	10 (18.5%)	13 (20.0%)
Other	17 (14.2%)	11 (20.4%)	6 (9.2%)
	Mean (*SD*)		
Age	29.4 (5.59)	28.4 (5.58)	30.3 (5.48)
Parity			
0	55 (46.2%)	24 (44.4%)	31(47.7%)
1	27 (22.7%)	11 (20.4%)	16 (24.6%)
2	18 (15.1%)	11 (20.4%)	7 (10.8%)
3	15 (12.6%)	6 (11.1%)	9 (13.8%)
≥4	4 (3.3%)	2 (3.7%)	2 (3.0%)
Prepregnant body mass index (BMI) (Kg/m^2)	31.2 (7.70)	30.1 (8.26)	32.1 (7.11)
Missing BMI	7	1	6
Comorbidities			
None	80 (67.2%)	35 (64.8%)	45 (69.2%)
Diabetes (all types)	29 (24.4%)	13 (24.1%)	16 (24.6%)
Hypoglycemic agents			
None	107 (89.9%)	49 (90.7%)	58 (89.2%)
Insulin	7 (5.9%)	2 (3.7%)	5 (7.7%)
Glyburide	2 (1.7%)	1 (1.9%)	1 (1.5%)
Metformin	1 (0.8%)	1 (1.9%)	0
Insulin & glyburide	2 (1.7%)	1 (1.9%)	1 (1.5%)

There were statistically significant differences between groups on infant gestational age, Ballard and pregnancy dating, as well as for infant weight ($p < .01$) (see Table 4). Furthermore, there were significantly more SGA infants in the pre intervention group than in the post intervention group ($p < .01$), while the postintervention group had significantly more LGA infants ($p < .01$) than the preintervention group.

Table 4: Selected Characteristics of Infants at Risk for Hypoglycemia

	Total Sample Sample ($N = 119$)	Preintervention ($n = 54$)	Postintervention ($n = 65$)
Males	57 (46.3%)	25 (46.3%)	32 (49.5%)
Females	62 (52.1%)	29 (53.7%)	33 (50.8%)
Appropriate for GA	87 (73.1%)	40 (74.1%)	47 (72.3%)
Large for GA	15 (12.6%)	3 (5.6%)**	12 (18.5%)**
Small for GA	16 (13.4%)	11 (20.4%)**	5 (7.8%)**
Missing GA	1	0	1
No Risk Factors	14 (11.8%)	6 (11.1%)	8 (12.3%)
Infant of Diabetic Mother	16 (13.4%)	7 (13.0%)	9 (13.8%)
Late Preterm	9 (7.6%)	7 (13.0%)	2 (3.1%)
Obese	54 (45.4%)	24 (44.4%)	30 (46.2%)
Multiple	4 (3.4%)	2 (3.7%)	2 (3.1%)
IDM + Obese	9 (7.6%)	1 (1.9%)	8 (12.3%)
IDM + LPT	1 (0.8%)	1 (1.9%)	0
Obese + LPT	5 (4.2%)	2 (3.7%)	3 (4.6%)
Obese + Multiple	2 (1.7%)	0	2 (3.1%)
Obese + Multiple + LPT	2 (1.7%)	2 (3.7%)	0
	Mean (*SD*)		
1 Minute APGAR	7.87 (1.42)	7.81 (1.63)	7.92 (1.22)
5 Minute APGAR	8.92 (0.52)	8.89 (0.54)	8.95 (0.51)
Pregnancy GA	38.9 (1.60)	38.4 (1.68)**	39.3 (1.43)**
Ballard	38.7 (1.77)	38.2 (1.92)**	39.2 (1.52)**
Birth Weight grams	3321 (620)	3140 (602)**	3471 (599)**

Note. GA = gestational age; IDM = infant of a diabetic mother; LPT = late preterm infant.
**$p < .01$.

Comparisons between the pre- and postintervention groups assessed the effectiveness and safety of the new SOC. These measures included (a) stabilized infant blood glucose defined as the total number of BG during the monitoring period; (b) decreased formula feedings; (c) increased breastfeeding attempts defined as breastfeeding prior to 1 hour of age, breastfeeding prior to use of formula, and total number of breastfeedings during the monitoring period; and (d) SCN admissions. The postgroup had significantly more documented breast feedings during the period of BG monitoring ($p < .05$). At the same time, there were

A breastfeeding standard of care based on the 2011 AAP guidelines for infants at risk for hypoglycemia can facilitate transition to extrauterine life.

no significant differences in the number of BG assessments each infant received, breastfeeding attempts prior to formula feeding, number of formula feedings, SCN admissions, or treatment with IV therapy (see Table 5).

Although there was not a difference in the overall number of BGs sampled per infant, the frequency of BG sampling was greater in the post- than the preintervention group. The postintervention group BG *SD* (2.96), mode (6), and range (2–19) were larger than in the preintervention group (1.17, 5, and 1–7, respectively) (see Table 5). Nine infants in the postintervention group were identified as having more than eight BGs until euglycemia, which would not have occurred under the pre intervention SOC. Their risk factors were LGA ($n = 5$), late preterm ($n = 3$), and weight > 4600 grams ($n = 3$). These nine infants needed additional support for transition to extrauterine life: six were admitted to SCN, with five receiving IV therapy. These infants were determined to cause a long-tail skew to the right in the distribution. When the analyses were repeated excluding these nine infants there was a significant decrease in SCN admissions and number of BGs per infant postintervention ($p < .01$) (see Table 5), and total number of breastfeedings per infant was no longer significant.

Table 5: Analyses of Infants' Responses to Intervention

	Total Sample Mean (*SD*)		Without ≥ 9 BG Mean (*SD*)
t-test	Preintervention $n = 29$	Postintervention $n = 62$	Postintervention $n = 53$
Number of blood gas/infant	5.69 (1.17)	5.92 (2.96)	4.92 (1.22)**
Number of formula feeds	1.57 (2.15)	1.24 (2.01)	0.81 (1.30)
Number of breast feeds	3.61 (2.32)	4.84 (2.50)*	4.60 (2.32)
Chi-Squared	Preintervention $n = 29$	Postintervention $n = 62$	Postintervention $n = 53$
Breastfed before formula fed	75.9%	81.5%	83.0%
Special care nursery admission	22.2%	12.3%	3.2%**
Treated with IV fluids	11.1%	10.8%	3.2%

Note. *$p \leq .05$; **$p \leq .01$.

Discussion

Implementation of evidence-based guidelines for neonatal hypoglycemia while ensuring compliance with breastfeeding guidelines was safe and effective. The use of Kotter's (1996) change model ensured involvement of all stakeholders and likely contributed to successful execution of the project. Furthermore, the financial implications were minimal, especially in light of the health benefit to mothers and infants.

The AAP (2011) guidelines were implemented safely and effectively. The nurses' identification of the infants at risk increased from 54% preimplementation of the revised SOC to 95% postimplementation allowing for early and timely interventions. The criteria used to identify infants at risk did not change from the preimplementation criteria. However, there was an increase in staff adherence with the revised SOC most likely due to the 2-year change process. The new SOC had more stringent requirements to determine when an infant had safely transitioned to extrauterine life. Previously two BGs ≥ 40 mg/dl were required at the end of the scheduled BG routine whereas the revised SOC required three consecutive BGs ≥ 45 mg/dl to establish euglycemia.

Although there was not a statistically significant difference in the number of BGs each group received, the postimplementation infants received more BGs than the preimplementation infants, which required further investigation. Nine infants received more intensive BG monitoring and clinical interventions. When these infants were removed from the sample and the data were reanalyzed, the infants who remained with their mothers breastfed more had fewer BG draws, with no increase in formula feedings, but the total number of breastfeeding attempts became nonsignificant. These findings suggest that even the sickest infants were given the opportunity to breastfeed.

Straussmand and Levitsky (2010) identified early breastfeeding as a minimally invasive, proactive treatment to prevent and treat neonatal hypoglycemia, and the AAP (2011) guidelines support breastfeeding. Despite the evidence, the staff survey results in Phase I confirmed staff members were divided regarding the effectiveness of breastfeeding as a treatment for hypoglycemia: 50% said it would work, and 50% said it would not work. Recognizing their concerns, providing a structured feeding plan that limited the amount of time an infant had to latch prior to formula introduction (15 minutes), and specifying the amount of breast milk and/or formula needed for each feeding (3–5 ml/Kg) enabled staff to promote breastfeeding in a manner acceptable to their practice and maintained patient safety. This was evidenced by the significant increase in total number of breast feedings that occurred ($p = .03$) postimplementation and a 5.6% increase in breastfeeding prior to feeding formula. The use of Kotter's (1996) change model, which supports and encourages staff involvement in the change process, likely fostered the success of this implementation.

Kotter's (1996) first step to organizational change is to create a sense of urgency. He indicated that environmental change may precipitate organizational change. The revisions to the SOC were needed to maintain Joint Commission accreditation and to remain in compliance with the NYS DOH (2011) regulations. The loss of support from either of these agencies could lead to a critical loss of revenue to the institution, resulting in a loss of employment for staff and providers and limiting access to care for our population. Furthermore, hypoglycemia can have negative effects on infant and family such as separation of mother and infant through SCN admissions and/or prolonged hospitalization. Early identification promotes early intervention, thus minimizing detrimental effects that potentially increase length of stay. This SOC provided early identification and intervention.

Doubling the identified infants that required glucose monitoring under the revised SOC resulted in an increase in cost of care. Additional testing equipment was needed to facilitate expedient testing. It also required more nursing time. This was not a true change related to the revised SOC because the identification criteria did not change. The revised SOC essentially improved adherence to the SOC, which necessitated increased BG sampling. Nurses became aware of which infants were at highest risk for developing hypoglycemia, and this prompted improvement in nursing care. The increased cost for BG monitoring is minimal when faced with the possible long-term health sequelae related to neonatal hypoglycemia that could cause an increased burden upon the health care system throughout the infant's entire lifetime (AAP, 2011).

Kotter's (1996) change model was used to safely and effectively implement this evidence-based practice change.

Limitations

This study was limited by the use of a convenience sample with a limited number of participants and was indicative of the population at that time. It was conducted in one facility, and the findings are not generalizable to the general population. The University of Texas at Austin (2007), the resource cited by Survey Monkey, defines a good response rate for e-mailed surveys to be 40%. The staff response rate was 39.5%, and respondents represented all care areas of the maternal/infant population.

Clinical Implications. Algorithms based on the 2011 AAP guidelines can be used to initiate a SOC change. In this case, the algorithms were perceived as being overwhelming at first. However, they contained a visual representation of the entire SOC. The users were provided with a detailed step-by-step approach to triaging infants at risk through the transitional period, the feeding plan with time and volume limits, BG monitoring, and specified appropriate actions using the SOC language. The actual use of the algorithms caused confusion among all staff, including the resource staff. After completion of the study period, a streamlined version that simplified the decision making process was created for staff to utilize (see Figure 1). The simplified algorithm was better accepted by the staff for the ease of use. This algorithm was placed in well-baby and SCNs as well as the labor and delivery unit, whereas two unabridged versions remained available in the patient rooms.

Completion of this project took more than 2 years and required a flexible and tenacious leadership style. This included a 1-year period for the development, implementation, and evaluation of the Phase I staff survey to ensure staff concerns were addressed and to promote buy-in with the change. Approval of the revised SOC through the interdisciplinary committee required multiple

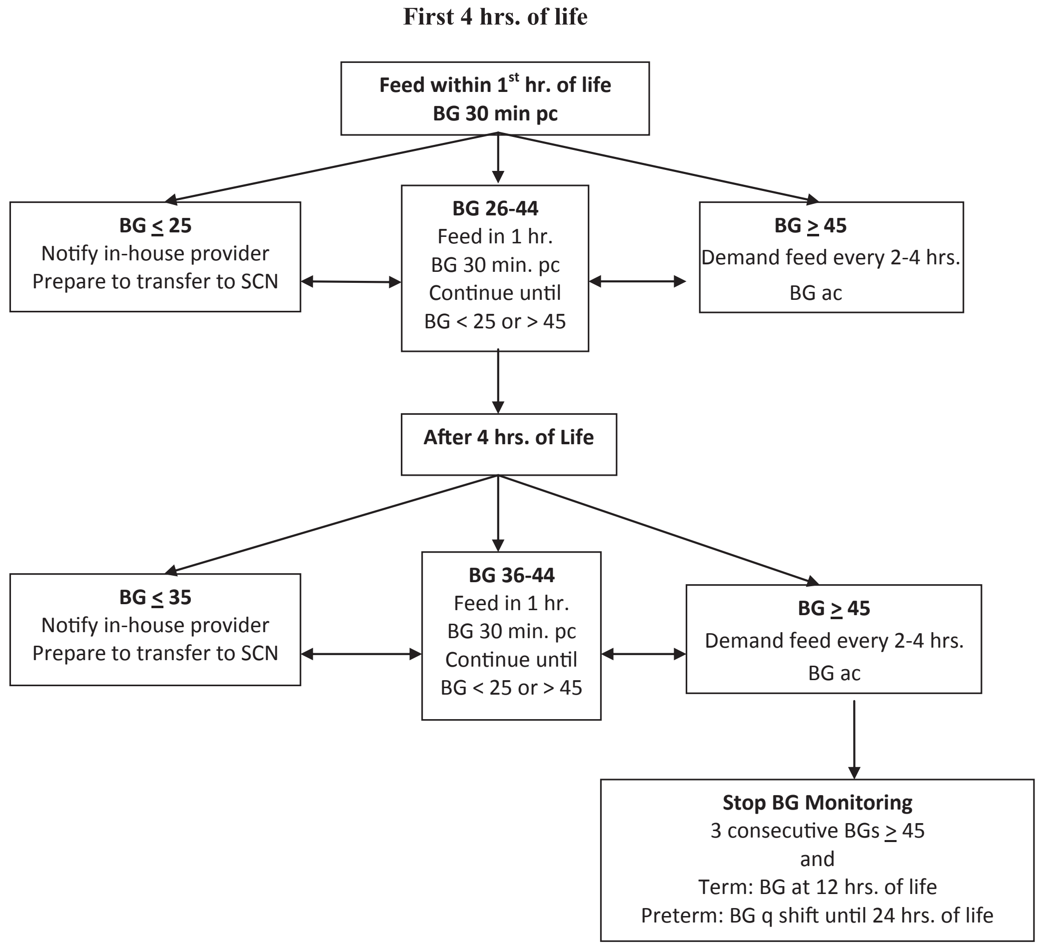

Figure 1. Simplified algorithm for blood gas protocol. BG = blood gas; SCN = special care nursery; pc = after feedings; ac = before feedings.

resubmissions over a 4-month period of time. The Research Subjects Review Board process for each phase of the project required separate applications. The implementation and evaluation was completed within a 4-month period, primarily due to the upfront attention to detail that is supported by Kotter's (1996) change model.

Ongoing monitoring is needed to reinforce the documented gains in management of breastfed infants at risk for hypoglycemia, as well as to ascertain patient safety and staff adherence. Grafting a new SOC to the unit culture requires years of reinforcement to ensure adherence (Kotter, 1996). Infant hypoglycemia has been a recurring focus for the quality assurance process of the institution. Development and initiation of an abridged monitoring process is still required to monitor infant safety and adherence to the new SOC and is currently being developed.

Implications for Future Research. With the suboptimal breastfeeding rates and an ongoing rise in obesity (Healthy People, 2012; NYS DOH, 2010, 2011; WHO, 2011), future research is needed to determine if this structured feeding plan has any effect on duration of breastfeeding, and if a correlation exists between maternal obesity and infant hypoglycemia. Currently obesity is an identified risk factor for neonatal hypoglycemia within the study institution. If obesity and infant hypoglycemia are correlated, further evaluation is needed to identify the obesity classification that places an infant at highest risk and what actions need to be taken to promote infant safety. Replication of this study at other institutions is needed to establish the feasibility of applying the findings to other health facilities.

Conclusions

A structured breastfeeding standard of care based on the AAP 2011 guidelines was used to safely and effectively manage infants at risk for hypoglycemia during the transition to extrauterine life. Although the initial findings suggest that the majority of staff were using breastfeeding as the first line of treatment for neonatal hypoglycemia after this process improvement project, extended reinforcement and monitoring will be necessary to ensure adherence to the revised SOC and continued infant safety.

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