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Improving the Diagnosis of Neonatal Hypoglycemia in a Well-Baby Nursery

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ABSTRACT

Point of care glucose (POCG) measurements, used for detecting neonatal hypoglycemia, can have variable accuracy. The appropriate diagnosis of neonatal hypoglycemia in babies with low POCG measurements involves confirmatory serum glucose (CSG) testing. At our institution, no babies with low POCG measurements had CSG testing in their evaluation of neonatal hypoglycemia over a three year period. Our aim was to increase the percentage of CSG testing in babies with a low POCG. A secondary aim was to decrease the percentage of low-risk, asymptomatic babies who received POCG testing. Interventions included the design and implementation of an evidence-based protocol for the diagnosis and management of neonatal hypoglycemia (cycle 1), along with supportive education for multi-disciplinary providers on best practices related to neonatal hypoglycemia (cycle 2). Data were analyzed using statistical process control. During Cycle 1, the percentage of CSG testing in babies with POCG ≤40 mg/dL significantly increased from 0 to 33%, and increased further to 63% during Cycle 2. The initial gain was sustained over 2 years. The percentage of POCG testing among low-risk asymptomatic babies was 40% at baseline and did not change during the project period. 18 babies with low POCG results were spared from a diagnosis of neonatal hypoglycemia based on CSG testing. Implementation of a neonatal hypoglycemia protocol, along with supportive education, significantly improved rates of CSG testing, but not POCG overutilization, in our newborn population. Factors related to POCG overutilization should be further explored.

PROBLEM

At our institution we anecdotally observed variation in the definition and management of neonatal hypoglycemia (NH), and in the criteria for transfer of babies with NH from the well-baby nursery to the neonatal intensive care unit (NICU). A protocol for NH evaluation and management existed but did not include confirmatory serum glucose (CSG) testing, which may have led to under or over diagnosis of NH. The appropriateness and utility of the protocol may have been limited by a lack of inclusion of updated evidence regarding management and a lack of guidance on at-risk populations. Additionally, the existence and location of the protocol was largely unknown among NICU physicians. This problem occurred in a mid-Atlantic teaching hospital that housed a Level IV NICU and a high-risk obstetrical service. The Mother-Baby Unit, which includes a well-baby nursery, has 23 maternal patient beds and is serviced by 53 nurses and 3 lactation consultants. Pediatric residents and pediatricians oversee the care of babies in the nursery, while board-certified neonatologists provide consultation and neonatal intensive care services in a separate 45 bed NICU.

Our mission was to standardize the diagnosis and management of NH for babies cared for in the well-baby nursery. By standardizing the practice, our intent was to reduce unnecessary separation of mother and baby for hypoglycemia management. The first step was to address appropriate diagnosis of NH. Our primary aim for this project was to improve CSG testing for babies with positive POCG screening by 20% over a six-month period. During the process of this quality improvement project, a secondary aim emerged, which was to decrease overutilization of POCG testing in low-risk asymptomatic babies by 20% over a six-month period.

BACKGROUND

Neonatal hypoglycemia can affect as many as 5-15% of healthy infants.[1] The risk of hypoglycemia may be as high as 72% in certain at-risk infants such as small for gestational age infants. There is currently not enough evidence to define a specific glucose value that results in long-term neurodevelopmental sequela.[2 3] There is also no single value associated with specific clinical signs of hypoglycemia, therefore it is difficult to determine the optimal value to intervene.[4] At best, we can aim to follow expert opinion and guidelines, which have generally recommended diagnosis of hypoglycemia at values less than 47 mg/dl in infants with risk factors, but this

value is not highly justified by the literature.[1 5 6] It is also important to note that some evidence demonstrates a normal physiologic nadir to 30 mg/dl. This commonly occurs in breastfed, normal newborn infants within the first one to two hours of life. The glucose level then rises above 45 mg/dL by 12 hours of life. This normal physiologic phenomena supports glucose monitoring only for those infants at risk of hypoglycemia.[4] The American Academy of Pediatrics recommends treating symptomatic infants with serum glucose values less than 40 mg/dL.[4]

Glucose monitoring is recommended for at risk infants including preterm infants, infants of diabetic mothers, small or large for gestational age babies, babies with dysmorphic features, or any infant with symptoms of hypoglycemia.[4] Point of care glucose (POCG) testing is a convenient screening tool for hypoglycemia in these at risk populations.[7] Point of care glucose measurements are rapid, technically easy to perform, and require a minimal amount of blood. However, POCG measurements can be inaccurate especially at low glucose concentrations.[7]

Factors that can affect glucometer results include: test strip expiration, ambient temperature or humidity level of the storage environment, blood sampling technique, and the presence of non-glucose sugars. Patient factors affecting glucometer results include metabolic acidosis, high blood oxygen tension levels, high bilirubin levels, high hematocrit levels, and/or edema.[7 8] Variation from actual serum glucose level may be as much as 10-20 mg/dL and greatest at lower glucose concentrations.[7] Considerable variation may occur with POCG testing, therefore the American Academy of Pediatrics recommends that confirmatory serum glucose testing, a more accurate method of measuring glucose, be performed to diagnose neonatal hypoglycemia.[4]

BASELINE MEASUREMENT

We retrospectively reviewed patient charts of babies transferred from the well-baby nursery to the NICU for NH from 2009-2012. Of 22 babies, none (0%) had received CSG testing. During our review in 2014, we observed that 40% of low-risk asymptomatic babies received POCG testing. As our goal was to increase the percent of CSG testing and decrease the percent of unnecessary POCG testing, these data were collected every three months following each intervention to assess for significant change. Monthly data were evaluated for special cause variation.

DESIGN

Prior to commencing the QI project we administered a needs assessment questionnaire, which enabled us to identify gaps in knowledge about NH and to understand the perspectives of well-baby nurses, pediatric trainees, and neonatologists with regard to NH management. This was completed in winter of 2012. Based on the findings, we hypothesized that an updated institutional protocol for diagnosis and management of NH would help to standardize the care of NH while helping clinicians adhere to evidence-based recommendations. The protocol was designed by neonatologists along with input from consulting pediatric endocrinologists and leadership from the well-baby nursing unit. The protocol included a uniform definition for NH and included management plans based on patient symptoms, risk factors, and serum glucose level. The protocol also defined appropriate criteria for transfer to the NICU. Due to the large staff and high-turnover of trainees, education was felt to be an important determinant of successful implementation and sustainability of the protocol. Educational sessions were created for the implementation of the protocol to orient staff to its use.

STRATEGY

In January 2013, we implemented an evidence-based hypoglycemia protocol in the well-baby nursery (see process flow diagram). This corresponds to plan-do-study-act (PDSA) cycle 1. We hypothesized that adoption of the protocol would result in a 20% increase in the appropriate diagnosis of NH, as defined by the percent of CSG testing in babies with low POCG testing. During this cycle we found that, despite an increase in utilization of CSG testing, many staff members had lingering questions related to appropriate hypoglycemia management.

In order to address these questions and maintain competency with the protocol, we instituted a year-long educational series that included a presentation explaining: the definition of neonatal hypoglycemia, appropriate diagnostic testing, limitations of POCG testing, our baseline compliance, and introduction to the QI project and the protocol. This series was targeted to nurses as well as the pediatrics and family medicine trainees. This educational series, PDSA cycle 2, started in January 2014 (see outline for educational series). There were a total of six sessions held throughout the year for this targeted audience (indicated by the asterisks in Figures 1a and b). We hypothesized that CSG would increase by an additional 20% following this intervention.

Based on our observations during PDSA 1, we noticed a significant number of babies without risk factors for NH who received POCG testing. We further intervened by including additional education on appropriate risk factors for POCG testing and baseline data on our overutilization of POCG testing starting March of 2014. We hypothesized that this targeted education would reduce overutilization of POCG testing. Overutilization was defined as the percent of low-risk asymptomatic babies that received POCG testing.

The primary measure was the percent of babies with POCG < 40mg/dL that also had a CSG testing. The secondary measure was the percent of low-risk asymptomatic babies that had POCG testing. Statistical process

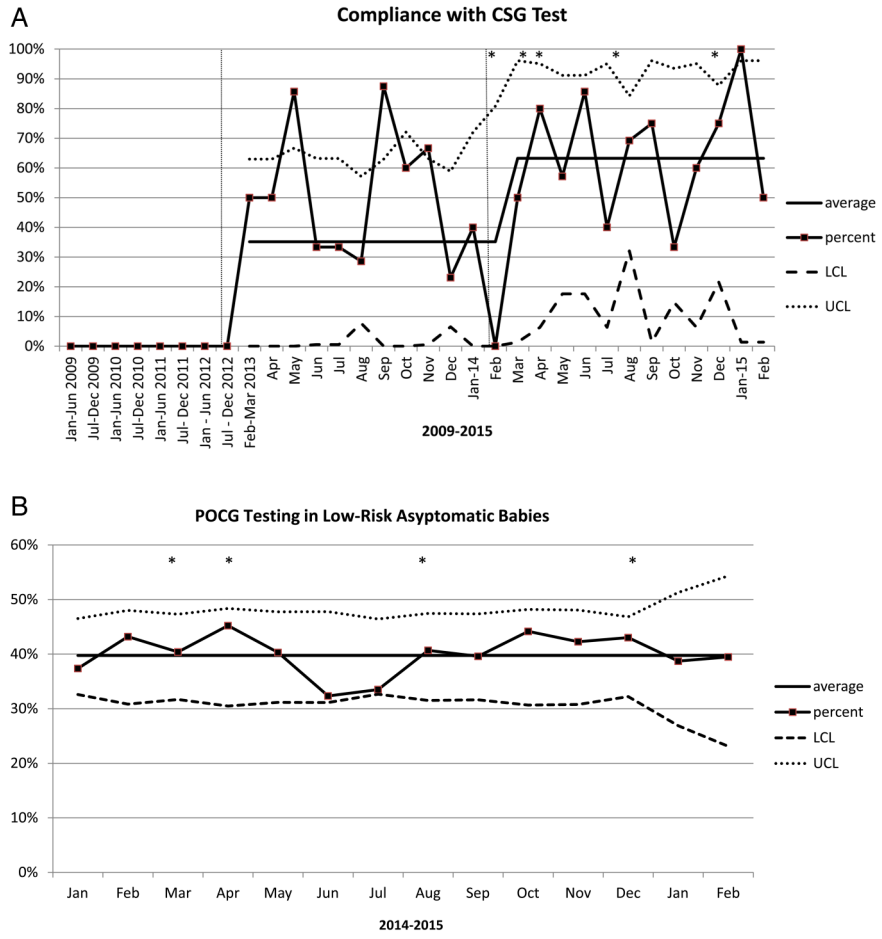

Fig 1. A LCL, lower control limit. UCL, upper control limit. Dashed vertical lines indicate start of cycles. Asterisks represent discrete educational events. B LCL, lower control limit. UCL, upper control limit. Asterisks represent discrete educational events.

control was used to identify significant changes over time. Data were plotted on p-charts demonstrating the monthly data values, average, upper control limits, and lower control limits. The average and control limits were reset using control chart interpretation rules as described by Amin.[9]

Our counter measure was the number of babies that were transferred from the well-baby nursery with critical NH, as defined by a presentation of seizures or shock, with no alternative etiology (See supplementary file - OUTLINE FOR EDUCATIONAL SERIES).

RESULTS

2435 patient charts were reviewed and 73 patients with hypoglycemia were identified. During Cycle 1 we observed > 7 consecutive points above the center line, which indicated that the percentage of CSG testing in babies with POCG ≤ 40mg/dL significantly increased from 0 to 33% (n = 122, Fig 1a). During Cycle 2, we observed > 7 consecutive points above the center line, representing another significant increase in our percentage of CSG testing to 63% (n = 72). The initial gain was sustained for 2 years. Over the course of the intervention from 2013-2015, there were a total of 18 babies who had POCG < 40 mg/dL, but had CSG values > 40 mg/dL (falsely positive POCG screens). The percentage of POCG testing among low risk asymptomatic babies was 40% and did not significantly change following our enhanced education (Fig 1b, n=1,851). There were no babies who were transferred to the NICU with critical NH following implementation of the protocol (See supplementary file - Process flow diagram).

LESSONS AND LIMITATIONS

Our quality improvement project demonstrates that a standardized up-to-date NH protocol, implemented with supportive education, significantly improved the appropriate diagnostic testing for NH. These improvements in diagnosis potentially prevented unnecessary NH management for 18 babies over a two-year period, a management which may include transfer to the NICU. The implied benefit of the project is increased opportunity for mother to baby bonding and a decrease in cost by allowing babies to safely remain at mother's side in lieu of NICU transfer. Although the cost associated with a NICU admission can be elusive due to the complexity of the health care financial system, we surmise that the cost of a NICU admission far exceeds the cost of one serum glucose test.[10] If compliance with CSG testing is further improved additional babies may be spared from management that includes disruption of mother-baby dyad and NICU admission. This highlights the importance of continued CSG testing in practice.

During this project we noticed that many low risk babies were receiving POCG testing. This led to our secondary goal to decrease overutilization of POCG testing, which has yet to be successful. We suspect that one underlying reason for not meeting this goal is related to the high turnover in nursing personnel, as new nurses may not be sufficiently educated on our institution's current hypoglycemia protocol. Another reason may be related to a perception that POCG testing is simple and harmless; therefore staff may have difficulty understanding the potential negative consequences of obtaining a falsely low POCG measurement. In general, overutilization is a potential source of poor healthcare quality as it can lead to waste and patient harm.[11 12] Additional and more frequent educational efforts may be needed to reduce the overuse of POCG testing in our practice. Another potential solution may be to incorporate point of care testing into our electronic medical record order sets, requiring a physician to approve POCG testing prior to nurse initiation.

There are limitations to this project. First, this was performed at a single institution; therefore it is difficult to determine how well our institution's hypoglycemia management protocol would be generally accepted across multiple establishments. Second, as briefly mentioned above, nurses are able to perform an initial POCG testing without orders from providers, therefore it is difficult to fully control the circumstances under which this happens. Lastly, there may be other factors leading to overutilization of POCG testing that have not yet been explored. A detailed assessment of such factors could lead to the development of effective interventions to curb unnecessary POCG testing.

We believe that our updated protocol is sustainable, as we have demonstrated a significant change in clinician practice over time. We plan to implement a yearly educational in-service for trainees and nursing staff. We also plan to publicly display progress for all staff to observe, a positive reinforcement to continue the improved practice.

CONCLUSION

In summary, we report that implementation of an evidence based protocol for the diagnostic evaluation and management of NH improved appropriate diagnostic testing in our practice. To our knowledge, this is the first published quality improvement report to improve the appropriate diagnosis of NH in a well-baby setting. Our project demonstrates that CSG testing reduced the burden of NH associated with false positive POCG screens. This improvement may have led to increased opportunities for mother-infant bonding. The adaptation of our protocol by other institutions may be a feasible approach to improving the effective care of babies at-risk for NH. Despite education on POCG overutilization, a reduction in overutilization was not observed; thus further inquiry into the determinants of POCG overutilization in our setting is warranted.

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Declaration of interests Nothing to declare.

Ethical approval This study was reviewed by the our institutional review board and not determined to be human subject research.

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