Implementation of the AAP Hyperbilirubinemia Guidelines in a Newborn Nursery to Appropriately Screen and Treat Newborns for Hyperbilirubinemia

A DISSERTATION

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For the Degree
Doctor of Nursing Practice

By
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Implementation of the AAP Hyperbilirubinemia Guidelines in a Newborn Nursery to Appropriately Screen and Treat Newborns for Hyperbilirubinemia

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Hyperbilirubinemia is the most common problem in the newborn period requiring hospitalization and medical attention. Kernicterus and bilirubin encephalopathy, “never events”, are rare but devastating disorders resulting from severe hyperbilirubinemia. The American Academy of Pediatrics (AAP) 2004 Hyperbilirubinemia Clinical Practice Guideline (CPG) was developed to support an approach to decrease the number of newborns who develop severe hyperbilirubinemia and bilirubin encephalopathy.

The purpose of this project was to implement and evaluate the impact of adoption of the AAP CPG in a normal newborn nursery. Anticipated clinical outcomes included a decrease in the number of serum bilirubin tests ordered and an increase in “the appropriate use” of phototherapy of healthy term newborns.

The Six Step Model for Implementing Evidence Based Practice guided the clinical practice change. Following adoption of the guidelines, retrospective chart reviews were conducted for a 6 week pre-implementation and post-implementation period. Both groups were roughly equivalent in terms of the number of newborns (115) with high initial transcutaneous bilirubin (TcB) levels requiring at least one confirmatory total serum bilirubin (TSB) level and the number requiring treatment with some phototherapy. However there was a significant difference between the two cohorts in terms of the number of TSBs ordered for each jaundiced newborn. In 2011, prior to implementation of the CPG, there were 199 TSBs obtained on 115 newborns with an average of 1.73 TSBs per newborn and a
range of 1-7 TSBs. Forty percent of this group of newborns received 2 or more TSBs during their hospital stay. In 2012, post-implementation of the CPG, 157 TSB were obtained on 115 newborns with an average of 1.37 TSBs per newborn, and a range of 1-5 TSBs. Only 22.6% of the 2012 cohort received 2 or more TSBs before discharged. Following implementation of the guidelines, there was also a significant increase in the use of “appropriate phototherapy” (p=0.048). In summary, implementation of the AAP CPG in the newborn nursery resulted in decreased lab costs, decreased nursing time an increase in nursing autonomy and most importantly, improved newborn care in the nursery.
This dissertation by Mary Elizabeth Flynn fulfills the requirement for the doctoral degree in Doctor of Nursing Practice approved by Elizabeth Hawkins-Walsh, PhD, CRNP, as Director, and by Janice G. Agazio, PhD, CRNP, and Francisco Alvarez, MD, as Readers.

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Dedication

There are many people that were instrumental in supporting me from the beginning to the end of this project. I am truly grateful to Elizabeth Hawkins-Walsh, PhD, CRNP, for her encouragement to start this program and for the time she spent mentoring me through the completion of this project. I would like to thank all of the nurses and doctors that I work with everyday in the newborn nursery that work tirelessly to improve newborn care. This couldn’t have been accomplished without you. Thank you, Francisco Alvarez, MD, for allowing me the time to design and complete this project on my time frame. To my sisters and friends who helped me through a few long semesters. And a very special thank you to my husband, Tim, and my children, Timothy, Aileena, Aidan and Moira. You are the best!
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CHAPTER ONE: NATURE OF THE PROJECT

Hyperbilirubinemia is the most common problem in the newborn period requiring hospitalization and medical attention (Alkalay, Breesee, & Simmons, 2010; Larson, 2008). Approximately sixty percent of all newborns will develop some degree of jaundice in the first week of life. By day three of life, most full term healthy newborn will have a peak bilirubin level of 6-8 mg/dL while preterm or late preterm newborn at day five of life will have a peak bilirubin level of 10-12 mg/dL (Misra, Agarwal, Deorari, & Paul, 2008). These bilirubin levels are consistent with physiologic jaundice of the newborn and are expected to resolve uneventfully without treatment. Bilirubin levels that exceed the level of physiologic jaundice levels are generally described as hyperbilirubinemia and usually warrant close follow-up and/or treatment. There is a lack of consistency in the literature in defining what constitutes hyperbilirubinemia. In many cases hyperbilirubinemia in the newborn is defined by the actual laboratory level of bilirubin while in others it refers to a level that requires treatment to control or lower the bilirubin level.

Determining a safe versus an unsafe bilirubin level is an unpredictable task (Bhutani, Johnson, Schwoebel, & Gennaro, 2006) and despite significant research in this area, there are still no absolute numbers that define unsafe bilirubin levels for all healthy newborns (Ip et al., 2004). Uncertainty regarding what level of bilirubin poses risk for a newborn complicates the management of hyperbilirubinemia. Under-screening and failing to treat can contribute to the well recognized risk of hyperbilirubinemia encephalopathy. Yet this uncertainty can also lead to less well recognized risks associated with over-screening and unnecessary treatment, including unnecessary laboratory testing, prolonged hospitalization,
parental anxiety, interference with breastfeeding and increased health care costs.

The American Academy of Pediatrics (AAP) recommends the use of intense phototherapy for healthy newborns who meet the established criteria for hyperbilirubinemia treatment (AAP, 2004). Phototherapy has been used for over thirty years on millions of newborns with rare reported occurrences of toxic effects (AAP, 2004). Yet, phototherapy has been attributed to self resolving issues of weight loss, diarrhea, dehydration (Marcdante, Kliegman, Jenson, & Behrman, 2011; US Preventive Services Task Force, 2009), skin rash, lethargy, nasal obstruction from use of eye pads, and possible retinal damage in the newborn (Marcdante et al., 2011). Additional concerns include interference with maternal infant bonding and interruption of breastfeeding (U.S. Preventative Services Task Force, 2010) while more recent studies indicate a potential correlation with a melanocytic nevi growth (Csoma et al., 2011; U.S. Preventive Services Task Force, 2010). Further research is needed to determine if there are, as yet unrecognized, adverse effects associated with phototherapy use (US Preventive Services Task Force, 2009).

The AAP (2004) supports an approach that attempts to balance the risks between failure to identify possible risk of severe hyperbilirubinemia and those associated with overtreatment. The AAP guideline stresses the importance of recognizing those newborns that are at risk for developing severe hyperbilirubinemia by recommending universal risk assessments and/or pre-discharge transcutaneous bilirubin (TcB) or total serum bilirubin (TSB) testing, ensuring close follow up after discharge, and initiating prompt and appropriate phototherapy when indicated.
Background

Kernicterus is a severely debilitating and often fatal neurotoxic disorder in newborn infants. It is characterized by the staining of the newborn’s brain tissue yellow that results in an acute or chronic bilirubin encephalopathy (Ip et al., 2004; US Preventive Services Task Force, 2009). Newborns with kernicterus have between a 5 (Bhutani et al., 2006) and 10 percent mortality rate (Burke et al., 2009) and an estimated 70 (AAP, 2004) to 88 percent morbidity rate (Bhutani et al., 2006). Newborns diagnosed with kernicterus have the potential of developing athetoid cerebral palsy, sensorineural hearing loss, paralysis of upward gaze and/or cognitive or intellectual deficits (AAP, 2004; Bhutani et al., 2006; US Preventive Services Task Force, 2009). Unfortunately, in healthy term and near term newborns, determining a safe from an unsafe bilirubin level is an unpredictable task (Bhutani et al., 2006).

The National Quality Forum in 2002 stated that kernicterus should be a “never event” and with the incidence of kernicterus still prevalent in the United States, Canada and Western Europe, they suggested that it be a reportable disease (Burke et al., 2009; Maisels et al., 2009). However as it is still not currently a reportable disease, the exact incidence of kernicterus is unknown (Burke et al., 2009; US Preventive Services Task Force, 2009).

In 2004, amidst increased reports of kernicterus, the AAP (2004) revised the Hyperbilirubinemia Clinical Practice Guideline (CPG). The current recommendations are for all newborns 35 weeks gestation and older to receive routine assessments and a review of their risk factors associated with the development of hyperbilirubinemia during their hospitalization. Because a reliable test to identify all newborns at risk for developing acute
bilirubin encephalopathy (ABE) is not available (US Preventive Services Task Force, 2009) the AAP developed guidelines that recommend that all newborns receive routine risk assessments and screening at discharge with either a TcB or TSB level. Evidence remains inconclusive to prove that the AAP guidelines decrease the incidence of bilirubin encephalopathy, but it is believed that they have decreased the incidence of severe hyperbilirubinemia while potentially increasing the use of treatment with phototherapy (Maisels et al., 2009).

**Scope of the Problem**

According to Newman (2009), between six and ten percent of all newborns need to be treated with phototherapy to prevent one newborn from developing a TSB greater than 20 mg/dL. The AAP (2004) states that between five to ten newborns with a bilirubin level between 15-20 mg/dL need to be treated to prevent one newborn from reaching 20 mg/dL. Mishra et al. (2008) determined that between five to ten percent of all newborns will require treatment with phototherapy for significant hyperbilirubinemia.

Bhutani, Committee on Fetus and Newborn, & AAP (2011) states that the response to phototherapy is dependent on the efficacy of the phototherapy devices being used and the balance between the newborns rate of production and elimination of bilirubin. Effective treatment requires maximizing the exposure of the newborn’s body surface to the phototherapy devices and this may require more than one light source (AAP, 2004). Unfortunately, there is a lack of standardization of equipment to determine the exact dosage of phototherapy necessary for the treatment of hyperbilirubinemia (Bhutani et al., 2011).
**Problem.** A 437 bed community hospital in Fredericksburg, VA has over 3400 newborn deliveries per year, totaling approximately 280 deliveries per month. In 2010, roughly 3000 newborns were admitted to the healthy newborn nursery. Approximately 35% of these healthy term and late preterm newborns were diagnosed with hyperbilirubinemia and about ten percent were treated with various forms and durations of phototherapy during their birth hospitalization. A uniform policy regarding screening and treatment of hyperbilirubinemia was lacking. Twenty-five to 30 providers were credentialed to care for newborns admitted to the healthy newborn nursery. These providers differed in their approaches, often without regard to the guidelines promoted by the AAP. The AAP Hyperbilirubinemia CPG recommends universal risk assessments and suggests that providers assess each newborn for presence and absence of recognized risks in making decisions regarding when and how to test for hyperbilirubinemia. A critical tool is the use of a nomogram to assist in interpretation of bilirubin levels based upon the age of the newborn. When bilirubin testing is done too early, the results are often meaningless and likely to result in the need for additional testing. Finally, the guidelines make recommendations regarding the type of phototherapy (high intensity) to use when it is indicated.

In reviewing the absence of a consistent approach to hyperbilirubinemia at this hospital, nursery staff were concerned that a failure to adopt nationally endorsed guidelines was contributing to premature and overly frequent bilirubin testing, leading to unnecessary painful heel sticks and lab tests, over-diagnosis, unnecessary treatment, prolonged hospital stays and increased health care costs.
Purpose

The purpose of this project was to implement and evaluate an evidence-based CPG for hyperbilirubinemia (AAP, 2004) in a healthy newborn nursery at a community hospital in Fredericksburg, VA. Implementation of this CPG was expected to improve the standard of care for newborns regarding the identification and treatment for newborns at risk for developing hyperbilirubinemia.

EBP Project Questions

Implementation of the evidence-based project was expected to improve the standard of care in the identification and treatment of newborns at risk for developing hyperbilirubinemia. Key questions to be answered were identified.

Would implementation of the CPG result in:

1. A decrease in the total number of TSB levels obtained on all newborns during their birth hospitalization?
2. An increase in the appropriate use of phototherapy for the treatment of hyperbilirubinemia?

Further questions to be answered over time will include whether adherence to the CPG over time will result in:

1. A decrease in the newborn’s length of stay when appropriately treated with phototherapy.
2. A decrease in newborn readmissions within 7 days after birth for hyperbilirubinemia.
Organizational Assessment

The setting was a 437 bed community hospital in Fredericksburg, VA. The nurses provide excellent quality care as acknowledged by receiving the Magnet Recognition Award in September 2009. A nursing director supervises the nursing staff on both the Mother-Baby and Pediatric Unit at this hospital. There are three assistant nurse managers who monitor the daily nursing activities, nursing communication and education specifically for the Mother-Baby Unit. The unit is staffed with both Registered Nurses (RN) and Licensed Practical Nurses (LPN) who provide routine newborn care on the unit. The nursing director, assistant nurse managers and nursing staff were also in agreement that there was a need for consistency in the diagnosis and treatment of newborns with hyperbilirubinemia.

In the early phase of this study, the healthy newborn nursery had two main contracted provider groups, the pediatric hospitalist and neonatologists that admitted approximately 90-95% of the newborns to the nursery. Five community pediatricians managed care to over five percent of the nursery newborns. The pediatric hospitalist group consisted of one pediatric nurse practitioner and ten pediatricians who provided care to the nursery for approximately 45% of the nursery volume. The neonatal group had approximately seven neonatal nurse practitioners and nine neonatologists who cared for a similar volume of newborns. On admission, the newborns were assigned to a hospital provider, pediatric hospitalist, neonatologist, or community pediatrician, based on a mother’s identified follow up. The pediatric hospitalist and neonatologists each had contracts with community pediatric groups/pediatricians to care for their practice’s
newborns that were born at the Fredericksburg, VA hospital. If the mother did not name a community pediatrician, the pediatric hospitalist was assigned to care for her newborn.

Nurse practitioners from both groups provided the majority of newborn care in the healthy nursery each morning and the physicians of both groups covered evening and overnight hours. Five local pediatricians admitted and provided routine care for their established families that delivered at this hospital and the newborns were followed up in their office after discharge. In 2011, approximately 30 providers provided routine care to newborns in this nursery.

A community pediatrician is the appointed Chief of Pediatric Medicine at this hospital. The pediatric hospitalists and neonatologists were contracted to provide the pediatric and neonatal care in the hospital and each group had a designated medical director. Both of these contracted groups were from two different medical facilities. The three directors were in agreement with the need to develop a standardized Hyperbilirubinemia CPG based on the AAP’s recommendations.

**Definition of Terms**

- **Term Newborn** is born at or greater than 37 weeks gestation (Seidel, Rosenstein, Pathak, & McKay, 2006).

- **Late Preterm Newborn** is born at or greater than 34 weeks and up to 36 and 6/7 weeks gestation (Fouzas, Karatza, Skylogianni, Mantagou, & Varvarigou, 2010).

- **Bilirubin** is the end product of the breakdown of red blood cells (Marcdante et al., 2011).
• **Conjugated (direct) Bilirubin** is water soluble bilirubin that has been metabolized by the liver to be excreted in bile (Thureen, Deacon, Hernadez, & Hall, 2005).

• **Unconjugated (indirect) Bilirubin** is bilirubin that has not been metabolized by the liver (Thureen et al., 2005).

• **Hyperbilirubinemia** is an excess of bilirubin in the blood (AAP, 2004).

• **Significant Hyperbilirubinemia** is a bilirubin level at or greater than 17 mg/dL after 72 hours of life or greater than the 95\textsuperscript{th} percentile on the AAP bilirubin nomogram (Goncalves et al., 2011).

• **Severe Hyperbilirubinemia** is a bilirubin level at or greater than 20 mg/dL (AAP, 2004).

• **Jaundice** is the yellow appearance to the newborn’s skin tone caused by an elevation of the serum bilirubin level (Seidel et al, 2006).

• **Physiologic Jaundice** is an elevated serum bilirubin in a newborn (Marcdante et al., 2011).

• **Pathologic Jaundice** is an elevated serum bilirubin level in a newborn, defined as an elevated bilirubin level >5 mg/dL within the first twenty-four hours of life, an increase in the bilirubin level of more than 0.5mg/dL per hour, or a conjugated (direct) bilirubin level of greater than 1.5 mg/dL (Seidel et al., 2006).

• **Kernicterus** is a neurotoxic disorder in newborns characterized by the staining of the newborn’s brain tissue yellow and is diagnosed by autopsy post mortem (AAP, 2004).
• **Acute Bilirubin Encephalopathy** is a potential medical condition in a newborn diagnosed with severe hyperbilirubinemia or kernicterus. Symptoms are poor feeding, high pitched crying, lethargy, extra pyramidal movements, abnormal gaze, and auditory dysfunction, which can progress to hypertonia or hypotonia, seizures, coma and death (Ip et al., 2004).

• **Total serum bilirubin** (TSB) is a bilirubin level from the blood, and it a total of the direct plus indirect bilirubin levels (Thureen et al., 2005).

• **Transcutaneous bilirubin** (TcB) is a painless, noninvasive method of providing a valid measurement of a TSB level by measuring the “reflectance data of multiple wavelengths from the bilirubin stained skin” (Mishra et al., 2008, p. 158).

• **Bilirubin nomogram** is a reliable and valid tool developed by V.K. Bhutani (Bhutani, Johnson, & Sivieri, 1999) used to determine a newborn’s risk for developing hyperbilirubinemia. It identifies risk zones after plotting the bilirubin level on the nomogram based on the newborn’s age in hours (AAP, 2004).

• **Bilirubin screening** is the performance of a pre-discharge TcB or TSB on all newborns (AAP, 2004).

• **Phototherapy** is a treatment for hyperbilirubinemia via a blue-green light therapy that aids in decreasing the serum bilirubin level (AAP, 2004).

• **Single phototherapy** (at the Fredericksburg hospital) is phototherapy treatment on a newborn wearing only a diaper with a fiber optic bili-paddle, the approximate length of the newborn’s torso, placed on or under the newborn’s torso.
• **Double phototherapy** (at the Fredericksburg hospital) is phototherapy treatment on a newborn wearing only a diaper lying flat, whose back is exposed to the light of a bili-bed with a fiber optic bili-paddle placed on the chest and abdomen. The bili-bed uses a single use cover blanket for the newborn during treatment to maintain warmth.

• **Triple phototherapy** (at the Fredericksburg hospital) is phototherapy treatment on a newborn wearing only a diaper and eye protection patches, lying flat on a fiber optic bili-paddle in an isolette, with two overhead phototherapy lights shining on the newborn. At this hospital this is the treatment of choice that meets the AAPs definition of intense phototherapy.

• **Intense phototherapy** is the term used by the AAP for treatment of hyperbilirubinemia based on the AAP phototherapy threshold guideline nomogram. High levels of light irradiance delivered to the largest possible surface area of the newborn (AAP, 2004).

• **Appropriate use of phototherapy** for this study is the use of intense phototherapy (triple phototherapy at the Fredericksburg hospital) to treat a newborn with hyperbilirubinemia. The bilirubin level must meet the AAPs criteria for phototherapy treatment based on the newborn’s age in hours, risk factor assessment (see Appendix E), and above or within 1mg/dL below the AAP phototherapy nomogram’s level to treat.
CHAPTER TWO

Evidence-Based Framework

Evidence-based practice (EBP) is “the integration of best research evidence with clinical expertise and patient values” (Institute of Medicine (US) Committee on Quality of Health Care in America, 2001, p. 147).

The Rosswurm and Larabee’s (1999) six step Model for Implementing Evidence Based Practice was chosen as a framework to conduct the implementation of the AAP Hyperbilirubinemia CPG in the newborn nursery in Fredericksburg, Virginia. This model was chosen for its simplicity of developing and implementing a practice change in an acute care facility plus for its importance of communicating results to the staff, facility, and to potential local or national audiences. This model has been successfully used to implement evidence based studies focusing on nurses providing direct patient care in a maternal-newborn environment (Larrabee, 2004).

Table 2.1: Model for Implementing Evidence Based Practice (Rosswurm & Larrabee, 1999)
1. Assess the need for practice change

The first step identified by Rosswurm and Larrabee (1999) involved assessing the need for change in practice. The problem was initially identified by nurses who were confused as to which newborns to test and what type of treatment providers would choose when a newborn was diagnosed with hyperbilirubinemia. Nurses identified the lack of consistency in care and inability to properly prepare a family if and when a newborn required treatment for hyperbilirubinemia. It was also learned that nurses randomly checked a newborn’s TcB when preparing to obtain a metabolic screening test. A heel stick was required for the metabolic screen and if the TcB required a TSB confirmation the nurse only wanted to stick the newborn’s heel once. This TcB was frequently done just after 24 hours of life and potentially increased the chances of more frequent bilirubin testing. This behavior likely led to newborns unnecessarily receiving multiple bilirubin levels and heel sticks to trend a bilirubin that usually did not require treatment.

Roughly 3000 newborns were admitted to the newborn nursery in 2010. Approximately 35% of these healthy term and late preterm newborns were diagnosed with hyperbilirubinemia and about ten percent were treated with various forms and durations of phototherapy during their birth hospitalization. According to Newman (2009), it is estimated that between six and ten percent of all newborns need to be treated with phototherapy to prevent one newborn from developing a TSB greater than 20 mg/dL. Mishra et al. (2008) determined that between five to ten percent of all newborns will require treatment with phototherapy for significant hyperbilirubinemia.
2. Link the intervention to process outcomes.

The 2004 AAP Hyperbilirubinemia CPG recommends risk factor assessments, pre-discharge bilirubin testing, and the use of the AAP nomograms to appropriately assess and develop a plan for follow up with their pediatric provider. A small percentage of newborns require treatment with phototherapy for hyperbilirubinemia. The role of the nurse was critical in the adoption of the CPG in the nursery. The nurse was most likely to support this practice change if he/she understood the physiology of hyperbilirubinemia, the associated risk factors and the value and limitations of screening. Nursing education prepared nurses to recognize newborns at risk for hyperbilirubinemia. Reinforcement of the guidelines by completion of clinical competency questions and feedback between nursing and the medical team facilitated the consistent use of the hyperbilirubinemia guideline. Nursing and medical staff worked together to adhere to the AAP guidelines to appropriately assess and screen newborns for hyperbilirubinemia during their birth hospitalization.

Both process and clinical outcomes were identified as follows:

Process Outcome

1. Nursing staff will understand the risks for hyperbilirubinemia.
2. Nursing staff will understand the causes for hyperbilirubinemia.
3. Nursing staff will adhere to the Hyperbilirubinemia CPG in making decisions on testing newborns’ bilirubin level during their birth admission.
Indicator: Nurses attended a presentation or reviewed the presentation on hyperbilirubinemia and completed clinical competency questions after reviewing the material.

Ultimate clinical outcomes

1. Decreased total number of TSB tests obtained on all newborns following the implementation of the AAP Hyperbilirubinemia CPG.

2. Increase in the number of healthy term or late preterm newborns treated appropriately with phototherapy for hyperbilirubinemia during their birth admission following the implementation of the AAP Hyperbilirubinemia CPG.

Indicator: Chart reviews of bilirubin testing and phototherapy treatment of newborns during their birth hospitalization.

Additional outcomes that will be monitored over time to determine the effectiveness of the CPG are the newborn’s length of stay and readmission rates for hyperbilirubinemia within the first week of life.

3. Critically analyze the evidence

A review of the evidence to support the development of the AAP CPG was conducted. The review of evidence to support the implementation of the Hyperbilirubinemia CPG is covered later in this chapter.

There are many studies to support the process of newborn assessment and screening for hyperbilirubinemia with a TcB or TSB with the hope of preventing and treating newborns before they develop severe hyperbilirubinemia. With all of the available data,
there is still limited evidence that the recommendations actually reduce the risk of developing ABE or kernicterus (U.S. Preventive Services Task Force, 2010). This is not surprising knowing that acute bilirubin encephalopathy is a rare event. However, until more evidence is available, adoption of the national professional organization’s CPG seems prudent when dealing with such a potential devastating but preventable problem.

4. Design practice change

Steps to implement the practice change were planned with input from all major stakeholders. Meetings with the assistant nurse managers, unit manager, and medical staff were held to discuss the current nursing process and to develop and design a plan for implementing the use of the AAP Hyperbilirubinemia CPG in the newborn nursery. Medical staff was in full support of the use of the AAP guideline. Development of preliminary tools to assist nursing in following the guideline were discussed and brought to meetings to review and address concerns prior to implementing the practice change (See Chapter 3 Project Methods).

The project was submitted to the Institutional Review Board for approval through Mary Washington Hospital and The Catholic University of America. Permission was obtained from both before the implementation of the CPG.

5. Implement and evaluate change

6. Integrate and Maintain change in practice

Step 5 and Step 6 are discussed in Chapter 3.
Literature Review

**AAP Clinical Practice Guideline.** There is a long standing controversy on the management and treatment of newborns with hyperbilirubinemia. In 1994, the AAP developed the first CPG for the management of hyperbilirubinemia for healthy term newborns, with a gestational age of greater than or equal to 37 weeks to address the controversy. Establishing a guideline was important due to the incidence of ABE and kernicterus, yet significant data was not available to be able to adequately provide precise recommendations for the management of newborns with hyperbilirubinemia. A strong emphasis was placed on the use of phototherapy as the primary method of treatment and close follow-up with their primary care provider within two to three days after discharge.

The current AAP Hyperbilirubinemia CPG was revised in 2004. The recommendations now include healthy newborns 35 weeks gestation and older and advocate for routine assessments of newborns for hyperbilirubinemia and supporting frequent and successful breastfeeding. Routine assessments include a risk assessment for the development of severe hyperbilirubinemia especially before discharge home. As with the previous guideline, attention continues to be placed on the need for close follow up with the newborn’s primary care provider within two days from discharge and the provision of appropriate treatment for hyperbilirubinemia as indicated (AAP, 2004). There have been updates and clarifications published since the 2004 guideline was established, but controversy still remains due to the limited evidence to support that the recommendations actually reduce the risk of developing ABE or kernicterus (U.S. Preventive Services Task Force, 2010). There are, however, many studies to support the processes in the assessment
and screening of newborns for hyperbilirubinemia with the hope of preventing and treating newborns before they develop severe hyperbilirubinemia.

**Universal screening with TcB or TSB.** The AAP (2004) CPG encourages routine risk assessments and screening newborns with either a Transcutaneous Bilirubin (TcB) or Total Serum Bilirubin (TSB) level prior to their discharge home. Multiple studies show that a TcB measurement is equivalent to a TSB in most healthy term and late preterm newborns. TcB values are a predictable means to determine a risk assessment for the development of hyperbilirubinemia without having to obtain a measurement with a painful heel stick (AAP, 2004). The AAP nomogram used to measure a newborn’s risk of developing hyperbilirubinemia was developed from a study performed by Bhutani, Johnson, and Sivieri (1999) based on the measurement of serum bilirubin levels. Minimizing painful heel sticks in a newborn is a priority for all providers but concerns have been expressed about the use of the AAP nomogram for the prediction of hyperbilirubinemia based only on a TcB rather than a TSB measurement (Varvarigou et al., 2009).

Maisels et al. (2009) confirms that either a TcB or TSB measurement is a quantitative measurement of a newborn’s risk for developing hyperbilirubinemia. The prospective cohort study by Fouzas et al., (2010) on 793 late preterm newborns, greater than or equal to 34 to 36 6/7 weeks gestation, admitted to the newborn nursery in Greece supports that a TcB measurement is equivalent to a TSB level. Additionally, this study confirmed that a lower gestational age was a significant finding in the development of hyperbilirubinemia. This study was performed on a small, predominately white population
in Greece limiting its generalization, but identifies that a TcB is an adequate screening tool for late preterm newborns.

Dalal, Mishra, Agarwal, Deorani and Paul (2009) followed TcB measurements of 972 healthy newborns 35 weeks gestation and older to determine if changes in TcB levels could assist in accurately predicting hyperbilirubinemia. This study shows that a single TcB measurement between 30 and 48 hours of life could reliably predict hyperbilirubinemia in healthy term and late preterm newborns in North India when plotted on the AAP nomogram. This study was not performed on a diverse population so it is difficult to generalize the results. This study also identified a relationship between independent predictors of a decreased gestational age with elevated TcB values and the need for phototherapy.

Maisels and Kring (2006) examined the ability of a rise in TcB levels in late preterm and term predominately white, breastfed newborn during the first 96 hours of life to predict hyperbilirubinemia. They found that bilirubin levels initially rise more rapidly during the first 6-18 hours of life, and then maintain a slower rate of rise between 18-42 hours of life before slowing further before reaching the peak. Data shows that a TcB is able to measure the changes in bilirubin values over time and was used to develop TcB specific nomograms for the institution. Again, lower gestational age was associated with higher TcB levels.

A prospective study in Greece by Varvarigou et al. (2009) evaluated 2039 predominately white, formula fed newborns, with a gestational age of greater than and equal to 35 weeks gestation. TcB values were found to predict hyperbilirubinemia in healthy newborns. In a comparison between the AAP nomogram and TcB values, data collected within the first 24 hours of life corresponded equally. Comparison of data beyond 48 hours
of life revealed differences between the TcB values and AAP nomogram. Data were used to develop a nomogram for their institution based on the measured TcB values. Population generalization is limited with this study due to the lack of sample diversity.

Many studies have found that the TcB may be a valid screening tool to test newborns for hyperbilirubinemia and have attempted to develop a TcB nomogram for this purpose. Due to differences in TcB devices and the lack of diversity of the populations, TcB testing alone is not adequate at this time, but is a good screening measurement that can minimize frequent painful heel sticks. Maisels et al. (2009) published recommendations of when to confirm a TcB with a TSB to prevent missing an elevated TSB level. When a TcB level is above the 75th percentile on the AAP nomogram, when a TcB level is greater than 13mg/dL, and prior to initiating any intervention for hyperbilirubinemia a confirmatory TSB should be obtained. Studies validate that the TSB and TcB levels are similar except when the TcB level is above 12-15 mg/dL (Ip et al., 2004; Maisels et al., 2009).

Using a TcB measurement in screening all newborns will decrease the need for number of heel sticks necessary to obtain a bilirubin level and relieve the nurses and parents of anxiety related to inflicting unnecessary pain to the newborn when screening for hyperbilirubinemia. Literature supports the use of a TcB for routine screening for hyperbilirubinemia. To confirm accuracy and to prevent missing an elevated bilirubin level, TSB levels should also be obtained based on the guidelines outline by Maisels et al., (2009) as noted above. Additionally, measuring the TcB level on the day of discharge and performing the routine metabolic screening at the same time can minimize the number of heel sticks performed on a newborn during their birth hospitalization (Maisels et al., 2009).
Institutions should routinely compare the TCB measurements to the lab’s serum measurement for accuracy of the TcB device for quality assurance (Ip et al., 2004).

**Implementation of the AAP CPG.** The AAP bilirubin nomogram, also referred to in the literature as the “Bhutani nomogram”, is a graph used to determine a newborn’s risk of developing severe hyperbilirubinemia based on newborn’s TSB value and their age in hours (Maisels et al., 2009). A large retrospective cohort study by Kuzniewicz, Escobar and Newman (2009) was completed at eleven Kaiser Permanente hospitals evaluating the incidence of severe hyperbilirubinemia after the implementation of the AAP clinical guidelines. The use of TcB and TSB measurements were used and plotted on the AAP nomogram. Readmission rates and the incidence of hyperbilirubinemia decreased after the implementation of the current AAP guideline. Incidentally, there was an increase in treatment with phototherapy after implementation of the guideline (Kuzniewicz et al., 2009). This study provides strong evidence that the use of the AAP guideline may prevent newborns from the development of severe hyperbilirubinemia but data are not clear on how many newborns would develop severe bilirubin encephalopathy. The consequence of universal screening could possibly lead to an unnecessary increase in the use of phototherapy. This study supports monitoring the frequency of bilirubin testing and use of phototherapy when implementing the AAP Hyperbilirubinemia CPG.

Alkalay, Bresee, and Simmons (2010) performed a retrospective study on newborns pre and post implementation of the universal bilirubin screening guidelines. A 60 percent decrease in readmission rates for hyperbilirubinemia was noted after the implementation of the AAP guidelines for universal bilirubin screening prior to discharge. This study
evaluated other variables that could potentially affect a change in readmission rates over
time such as breast feeding rates, annual delivery rates, length of stay and change in
ethnicity population before verifying that the implementation of the AAP guideline
improved newborn readmission rates for hyperbilirubinemia.

Use of phototherapy in the treatment of hyperbilirubinemia. Phototherapy has
been used for over forty years to effectively treat newborns at risk for developing severe
hyperbilirubinemia based on risk assessments on the AAP nomogram. Studies show that the
use of phototherapy is effective in lowering elevated bilirubin levels, but it remains unclear
if the use of phototherapy actually prevents newborns from developing ABE or kernicterus.
The AAP (2004) recommends the use of “intense phototherapy” when treating newborns
with hyperbilirubinemia, which is the equivalent light wavelengths measuring 400-480 nm.

Bhutani et al. (2011) reviewed the literature and evidence to standardize the use of
phototherapy in the treatment of hyperbilirubinemia. Millions of newborns have been
treated with phototherapy and there have been no documented serious adverse effects
attributed to its use. Treatment is based on the amount of skin exposure to the light rays and
the amount of wave lengths being emitted from the phototherapy device. Bhutani et al.
(2011) discovered a lack of standardization in devices to measure the amount of
wavelengths used with the treatment of phototherapy. Phototherapy devices all provide a
spectrum of efficacy and numerous choices of wave lengths for treatment for both hospital
and home use. A standard method of measuring an accurate strength of treatment would be
helpful in effectively studying hyperbilirubinemia treatment (Bhutani et al., 2011).
Bhutani et al. (2011) recommends that facilities educate all staff of the proper use and safety of the institution’s phototherapy devices. It is important to maintain proper distances between the equipment and newborn based on manufacturer recommendations while illuminating a newborn’s maximum body surface area. Hydration status, nutrition and temperature are additional parameters that need close supervision during phototherapy while also encouraging position changes every two to three hours.

Overuse of phototherapy has been addressed in studies especially after the implementation of the current AAP Hyperbilirubinemia CPGs, but there is a lack of insight on solutions to minimize or decrease the use of phototherapy in newborns (Kuzniewicz et al., 2009). It is quite possible that the decrease in readmission rates for hyperbilirubinemia may be due to the overuse of phototherapy.

Future research is needed in the use of phototherapy including methods to accurately measure the wave length of the device providing treatment, the use effectiveness of phototherapy at home, understanding potential short and long term consequences of using phototherapy, and the still unanswerable question of whether phototherapy truly prevents the risk of neurotoxicity in the newborn (Bhutani et al., 2011).
CHAPTER THREE: PROJECT METHODS

Project Design

The project design was a pre and post implementation study that compared two groups over a 6 week period. Retrospective chart reviews were conducted on the same six week period in the years 2011 (pre-guideline) and 2012 (post-guideline).

Methods

A critical step in implementing this quality improvement project was to assure that the nursing staff understood the causes and risk factors for newborns at risk for the development of hyperbilirubinemia. Education of the nursing staff was accomplished by scheduling four in-services throughout one week during all shifts, day, evening and night allowing the nursing staff ample opportunity to attend. A 30 minute power point presentation, a nursing algorithm and risk factor tool based on the Hyperbilirubinemia CPG (See Attachments A and B) was developed and presented to nursing staff as a review of newborns at risk for hyperbilirubinemia. The AAP Hyperbilirubinemia CPG recommends that nurses have the ability to obtain a bilirubin level on a newborn that they determine to be jaundiced. A nursing hyperbilirubinemia algorithm and risk factor tool adapted from the AAP recommendations was developed to assist nurses in the decision of when to obtain a bilirubin level during their birth hospitalization.

Eighteen (50%) of the 36 nurses on the Mother Baby Unit attended one of the four presentations. All staff and those who were unable to attend these sessions were given a copy of the power point presentation. Individual discussions and review of risk factors and tools were provided on an individual basis as possible. Copies of the power point
presentation and nursing reference tools were available to all nursing staff via email, placed in the break room and a nursery resource manual was developed for continued use as a quick nursery reference. Nurses were required to complete clinical competency questions after reviewing the material.

Minimizing painful heel sticks of the newborn is important to the family and all staff. Clustering routine screening tasks with the implementation of this guideline was a recommendation of the CPG to minimize unnecessary heel sticks in the newborn. Nurses were instructed to perform all routine screening exams; metabolic screening, congenital heart screen, and TcB/TSB, on the day of discharge. Nurses still maintained the ability to obtain a TcB at any time there was a concern for hyperbilirubinemia based on their routine assessments as recommended by the CPG.

The pediatric hospitalists as a group were aware of the AAP Hyperbilirubinemia CPGs and all had been following them when caring for newborns. A meeting was set up to discuss the AAP guidelines, the nursing algorithm and the treatment of newborns diagnosed with hyperbilirubinemia with the community pediatricians who provided nursery care. The materials were emailed to all and three of the seven attended the presentation. Positive feedback was received on the developed and presented project material.

All breastfeeding mothers had access to and the support of a certified lactation consultant during their birth hospitalization. Mothers were encouraged to breastfeed every 2 hours or at least 8-12 times per day. Breastfed newborns with significant weight loss (>4% per day or >7% on day of discharge) and/or identified as a poorly breastfeeding newborn were given priority status by lactation and evaluated at the beginning of their morning
rounds. Lactation consultants also attempted to evaluate all breastfed newborns on the day of discharge.

All newborns before discharge had a risk assessment and screened with a TcB or TSB to determine the risk of developing severe hyperbilirubinemia. Newborns determined to have significant hyperbilirubinemia after being plotted on the hour specific nomogram were evaluated for the need for phototherapy or close follow up with their primary care provider.

If the newborn required treatment based on the phototherapy hour specific nomogram, the newborn was to receive intense phototherapy, with repeat TSB levels obtained 6-12 hours after initiation of phototherapy. Intense phototherapy was triple phototherapy, at this hospital, and included two overhead spot lights directed on the newborn’s bare skin, diapered only, and lying on a bili-paddle or bili-bed.

The AAP (2004) strongly recommends that all newborns are evaluated by their primary care provider within a few days of discharge. All newborns regardless of gestational age and risk factors can develop significant hyperbilirubinemia. Newborns discharged before 72 hours of life were required to have a follow up within 48 hours of discharge. If a newborn was discharged on a Friday, the follow up often did not occur until Monday morning depending on their provider’s weekend office hours. Newborns with risk factors for the development of hyperbilirubinemia were required to have a 24 hour follow up or follow up bilirubin level in 24 hours (See Attachment E). There is a community clinic that was available to see a newborn on the weekend if the need was determined based on the
discharge risk assessment. Parents were given information upon discharge on hyperbilirubinemia and the necessity for close follow up.

**Evaluation**

The hospital’s data collection system captured data on all healthy newborns admitted to the nursery, any newborns diagnosed with hyperbilirubinemia and any hospital readmissions within 30 days of discharge. I reviewed the charts and data on all newborns admitted to the newborn nursery and diagnosed with or readmitted to the Pediatric Unit with hyperbilirubinemia during the six week periods of March 19 to April 30 in the years 2011 and 2012. An EXCEL spreadsheet was created and data entered on all newborns with the required data points (See Attachment D). Descriptive statistics allowed the description of the two cohorts of newborns according to date and time of birth, gestational age, gender, maternal blood type, newborn blood type, DAT test results, number of TSBs, treatment with phototherapy, TSB level at treatment, type of phototherapy ordered, duration of phototherapy, and hospital readmission within 7 days. Data were carefully gleaned for completeness, reviewed and cleaned after entry into the EXCEL spreadsheet. There were 326 charts reviewed for 2011 and 302 for 2012. After all charts were reviewed and data entered into the spreadsheet, newborns meeting exclusion criteria, as detailed below, were removed from the spreadsheet. In 2011, the 35 newborns that were DAT positive, five NICU transfers, and one newborn was readmitted for hyperbilirubinemia treatment that was delivered at an outside hospital were removed from the database. In 2012, there were 22 DAT positive newborns and 16 NICU transfers removed from the database.
Chart reviews were performed monthly by the hospitalist staff to determine the appropriate use and effectiveness of the CPG and to routinely report results to the nursing and medical staff.

Anticipated outcomes from the comparison of the pre and post guideline implementation:

Process Outcome

1. Nursing staff will understand the risks for hyperbilirubinemia.
2. Nursing staff will understand the causes for hyperbilirubinemia.
3. Nursing staff will adhere to the Hyperbilirubinemia CPG in making decisions on testing newborns’ bilirubin level during their birth admission.

Indicator: Nurses attended a presentation or reviewed the presentation on hyperbilirubinemia and completed clinical competency questions after reviewing the material.

Ultimate Clinical Outcomes

1. Decreased total number of TSB tests obtained on all newborns following the implementation of the AAP Hyperbilirubinemia CPG.
2. Increase in the number of healthy term or late preterm newborns treated appropriately with phototherapy for hyperbilirubinemia during their birth admission following the implementation of the AAP Hyperbilirubinemia CPG.

Indicator: Chart reviews of bilirubin testing and phototherapy treatment of newborns during their birth hospitalization.
Anticipated long term outcomes are a:

1. Decrease in the length of stay for health term or late preterm newborns treated with phototherapy for hyperbilirubinemia during their birth admission following the implementation of the AAP Hyperbilirubinemia CPG.

2. Decrease in the number of newborns readmitted to the pediatric unit for treatment of hyperbilirubinemia within the first week of life.

**Human Subject Protections**

This project focused on the implementation of the recommended AAP Hyperbilirubinemia CPG and data obtained through retrospective chart reviews. Patient identifiers were not attached to any data collection method and there was no anticipated risk or harm to the newborn with the implementation of this project.

**Sampling Plan**

The pediatric hospitalists, community pediatricians, and Mother Baby Unit nursing staff at the hospital in Fredericksburg, VA participated in the implementation of the Hyperbilirubinemia CPG on healthy newborns admitted to the newborn nursery.

**Inclusion criteria.** All newborns greater than or equal to 35 weeks gestation admitted to the newborn nursery during two separate six week periods between March 19 to April 30 in the years 2011 and 2012 were included in the study.

**Exclusion criteria.** Newborns diagnosed with ABO incompatibility as confirmed with a positive DAT test or admitted to the NICU for greater than the 6 hours of transitional care were excluded from the study. (See Attachment D)
CHAPTER FOUR: RESULTS

Chart reviews were performed on newborns meeting the outlined project criteria over a six week period pre and post-implementation of the AAP guidelines from March 19 to April 30, 2011 and 2012.

Demographic Findings

The 2011 pre-implementation group contained 285 newborns, 148 (51.9%) males and 137 (48.1%) females. The post-implementation group contained 274 newborns with 135 (49.3%) males and 139 (50.7%) females, netting a slight difference of 11 more newborns in 2011. Both the number of newborns and gender distribution of the two groups were similar (Table 1).

<table>
<thead>
<tr>
<th>Table 4.1 Gender ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>n=285 (%)</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>148 (51.9)</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>137 (48.1)</td>
</tr>
<tr>
<td>n=274 (%)</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>135 (49.3)</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>139 (50.7)</td>
</tr>
</tbody>
</table>

All newborns were screened during their hospitalization with a TcB if noted by the nurse to be significantly jaundiced or at discharge. A TSB was performed on those newborns with a TcB which when plotted on the AAP nomogram, was found to be in the high intermediate or high risk zone for the development of hyperbilirubinemia. Both groups had the same number of newborns (115) with high initial TcBs requiring at least one confirmatory TSB. This number represented 40.4% in 2011 and 42% of newborns in 2012 that required minimally one confirmatory TSB before discharge home (Table 2).
In 2011, a slightly higher percentage of males (56.5%) required confirmatory TSBs than females (43.5%) whereas in 2012, 54% of females and 46% of males required confirmatory TSBs for elevated TcB readings (Table 3).

### Table 4.3 Gender ratio requiring confirmatory TSBs

<table>
<thead>
<tr>
<th>3/19- 4/30</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011 NB (n=115)</td>
<td>65 (56.5)</td>
<td>50 (43.5)</td>
</tr>
<tr>
<td>2012 NB (n=115)</td>
<td>53 (46)</td>
<td>62 (54)</td>
</tr>
</tbody>
</table>

Newborns born prior to 38 weeks gestation are at greater risk for the development of hyperbilirubinemia, and the risk significantly increases for late preterm newborns. The gestational age range between the groups varied slightly. In 2011, the newborns ranged in age from 35 5/7 weeks to 42 2/7 weeks gestation. In 2012, newborns ranged from 35 weeks to 41 2/7 weeks gestation. Both groups have a similar percentage of newborns born prior to 38 weeks gestation with 17.5% in 2011 and 17.9% in 2012. In 2011, 22.5% of newborns were born at or greater than 40 weeks gestation and 23.4% in 2012. Although these percentages are similar, it should be noted that there are two times as many newborns born at less than 36 weeks gestation in 2012 (Table 4).
**Outcomes**

**Process outcomes.** The standing orders for nurses to autonomously check a bilirubin when concerned for jaundice never changed with the implementation of this study. The nursing staff learned when to be concerned about a jaundiced newborn. The nursing staff began assessing the newborns for both risk factors and jaundice and made more judicious decisions in checking a newborn for jaundice before their discharge. The nursing algorithm and the hyperbilirubinemia risk factor tool assisted nurses in determining the need to obtain a bilirubin before the day of discharge. Nurses changed their routine of performing the newborn screenings at 24 hours of life and began to cluster all screenings on the day of discharge. Through nursing’s process change they were able to adhere to the AAP Hyperbilirubinemia CPG without causing any unwanted outcomes.

**Ultimate outcomes.** In 2011, pre-implementation of the CPG, there were 199 TSBs obtained on 115 newborns with a range of 1-7 TSBs obtained per newborn. This averaged to 1.73 TSBs per newborn with 40% of those newborns receiving 2 or more TSBs during their hospital stay. In 2012, post implementation of the CPG, 157 TSBs were obtained on 115 newborns with a range of 1-5 TSBs obtained per newborn. This averaged to 1.37 TSBs per newborn with only 22.6% receiving 2 or more TSBs before discharge (Table 5).

<table>
<thead>
<tr>
<th>Table 4.4 Gestational ages</th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>35.5-42.2</td>
<td>n=285</td>
<td>2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40+</td>
<td>64 (22.5)</td>
<td></td>
<td>64 (23.4)</td>
</tr>
<tr>
<td></td>
<td>38-39.6</td>
<td>171 (60)</td>
<td></td>
<td>161 (58.7)</td>
</tr>
<tr>
<td></td>
<td>36-37.6</td>
<td>47 (16.5)</td>
<td></td>
<td>43(15.7)</td>
</tr>
<tr>
<td></td>
<td>&lt;36</td>
<td>3 (1)</td>
<td></td>
<td>6 (2.2)</td>
</tr>
</tbody>
</table>
Table 4.5 Newborns receiving TSBs

<table>
<thead>
<tr>
<th>3/19- 4/30</th>
<th>NB (n=)</th>
<th># NBs with TSB (%)</th>
<th>TSBs (per NB)</th>
<th>≥ 2 TSBs per NB (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>285</td>
<td>115 (40.4)</td>
<td>199 (1.73)</td>
<td>45 (40)</td>
</tr>
<tr>
<td>2012</td>
<td>274</td>
<td>115 (42)</td>
<td>157 (1.37)</td>
<td>26 (22.6)</td>
</tr>
</tbody>
</table>

In 2011, 19 of 285 (6.7 %) newborns received phototherapy for the treatment of hyperbilirubinemia but only 4 (21.1 %) were treated appropriately. In 2012, 16 of 274 (5.8 %) newborns received phototherapy and 7 (43.8%) were treated appropriately. Three newborns in 2012 were treated inappropriately due to multiple newborns requiring simultaneous phototherapy and the lack of equipment to meet this need. While all newborns diagnosed with hyperbilirubinemia were able to be treated with phototherapy not all with triple phototherapy, thereby not being included in those who were defined as “appropriately treated”. If adequate equipment had been available, the number of newborns “appropriately treated” in 2012 would have been 62.5% (Table 6).

Table 4.6 Newborns treated with phototherapy (Ptx)

<table>
<thead>
<tr>
<th>3/19 - 4/30</th>
<th>NB</th>
<th># NB rec’d Ptx (%)</th>
<th># NBs rec’d approp tx (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>285</td>
<td>19 (6.7)</td>
<td>4 (21.1)</td>
</tr>
<tr>
<td>2012</td>
<td>274</td>
<td>16 (5.8)</td>
<td>7 (43.8)*</td>
</tr>
</tbody>
</table>

* Equipment not available to appropriately treat 3 newborns with triple phototherapy.

Single tailed t-tests were performed to analyze the significance of the differences found in the number of TSBs performed on newborns and in the increased number of newborns who received the “appropriate use of phototherapy”. No statistical significance was found between the two groups in the total number of TSBs on all newborns admitted to the nursery (p=0.067). However data analysis shows statistical significance in decreasing the number of confirmatory TSBs required post implementation of the CPG (p=0.003). The data also show statistical significance in increasing the number of newborns appropriately
treated for hyperbilirubinemia (p= 0.048) in 2012 (Table 7). If adequate equipment were available, 10 (62.5%) of the newborns would have been appropriately treated for hyperbilirubinemia thus improving the power of significance to p=0.007. After implementing the CPG there was an overall decrease in the number of TSBs obtained on newborns and there were 3 less newborns requiring phototherapy.

**Table 4.7 Comparison of ultimate outcomes**

<table>
<thead>
<tr>
<th>3/19 - 4/30</th>
<th>2011</th>
<th>2012</th>
<th>P =</th>
</tr>
</thead>
<tbody>
<tr>
<td># NB (# TSB)</td>
<td>285 (199)</td>
<td>274 (157)</td>
<td>0.067</td>
</tr>
<tr>
<td># TSBs (per NB)</td>
<td>199 (1.73)</td>
<td>157 (1.37)</td>
<td>0.003</td>
</tr>
<tr>
<td>NBs approp. tx (%)</td>
<td>4 (21.1)</td>
<td>7 (43.8)*</td>
<td>0.048</td>
</tr>
</tbody>
</table>

* Equipment not available to appropriately treat with triple phototherapy on 3 newborns.

**Additional Noted Findings**

Data will be collected on the two additional outcomes, length of stay (LOS) and readmissions within seven days of discharge for newborns diagnosed with hyperbilirubinemia. These will require long term monitoring post implementation of the Hyperbilirubinemia CPG. Both pre and post implementation groups had a similar average duration of phototherapy during their birth hospitalization for hyperbilirubinemia. In 2011, the average treatment time was 22.5 hours compared to 20 hours in 2012 (Table 8). Although these numbers are similar, there are already noted differences in type of phototherapy and the newborn’s LOS (Table 8).

In 2011, of the 19 newborns treated with phototherapy, two newborns were placed on bili-blankets on the day of discharge, with orders for discharge on home phototherapy. A
third newborn received a verbal order from the on call pediatrician to start phototherapy and 2 hours later the pediatrician rounding for that day discontinued therapy. Of the remaining 16 newborns, the length of treatment ranged from 8-64 hours, averaging to 22.5 hours per newborn. Six of these 16 newborns required a combined nine additional hospital days above the recommended routine LOS (2 days). Three of these six newborns required two additional days each for phototherapy treatment. Of these same three newborns, only one had a TSB that met criteria for phototherapy based on the AAP phototherapy nomogram. None of the six newborns were treated appropriately for hyperbilirubinemia. Three of the six newborns requiring additional hospital days had TSBs that did meet criteria for treatment but were treated with either single or double phototherapy rather than the recommended triple phototherapy.

In 2012, there were 16 newborns treated during their birth hospitalization for hyperbilirubinemia. Treatment ranged from 9-42 hours leading to six newborns each requiring an additional day in the hospital. Of the newborns requiring an additional night in the hospital, two were inappropriately treated due to the lack of adequate equipment, two did not meet criteria for treatment and two met treatment criteria and were treated appropriately.

<table>
<thead>
<tr>
<th>3/19 - 4/30</th>
<th>NB with Ptx (%)</th>
<th>Total Hrs NBs rec’d Ptx (Ave hrs/NB)</th>
<th>Add’l hospital days</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>19 (6.7)</td>
<td>428 (22.5)*</td>
<td>9</td>
</tr>
<tr>
<td>2012</td>
<td>16 (5.8)</td>
<td>326 (20)</td>
<td>6**</td>
</tr>
</tbody>
</table>

*Excludes the hours of phototherapy for the 2 newborns d/c home on bili-blankets
**2 newborns were inadequate treated due to lack of equipment.
A difference was noted between the duration and treatment methods used to diagnose newborns with hyperbilirubinemia when comparing the three provider groups. In 2011, both the neonatology and hospitalist group treated seven newborns each for hyperbilirubinemia. When the neonatology group managed the newborns with hyperbilirubinemia, their average length of treatment per newborn was 37 hours. The pediatric hospitalist had an average duration of treatment of 15 hours per newborn treated for hyperbilirubinemia. The community pediatricians managed the remaining 5 newborns and their average treatment time was difficult to quantify due to the fact that two newborns were started on bilirubin blankets with the plan to discharge them with home phototherapy and one was treated for less than two hours. The remaining two newborns that received phototherapy had an average length of treatment of 10 hours per newborn. In 2011, all of the newborns that required additional days for treatment were managed by the neonatology group in 2011.

Nine newborns between the two study groups were readmitted for phototherapy treatment. Although there was no difference in the number of readmissions within the first week of life between the study groups, there was a difference in the gestational ages of the readmitted newborns (Table 9). Late preterm newborns (born prior to 37 weeks gestation) have a recognized increased risk for hyperbilirubinemia and that their bilirubin levels often rise up to five days of life (Mishra et al., 2008). With discharges typically occurring before 48-72 hours of life, late preterm newborns are at an increased risk for readmission with hyperbilirubinemia. The AAP CPG identifies newborns less than 38 weeks gestation at risk for developing “severe” hyperbilirubinemia (AAP, 2004). In 2011, only one of the five
newborns readmitted for hyperbilirubinemia was a late preterm newborn with a gestational age of 36 1/7 weeks. The gestation age of the other four newborns ranged from 39 weeks to 40 1/7 weeks which per the AAP CPG are low risk newborns. In 2012, three of the four newborns readmitted with hyperbilirubinemia within one week of life were considered by the AAP guideline to be at high risk for “severe” hyperbilirubinemia due to their respective gestational ages of 35, 36 5/7, and 37 3/7 weeks. The other newborn met the definition of “term” but was also younger (38 3/7) than the expected 40 weeks gestation. Due to the lower gestational ages of the 2012 newborns who were readmitted, all but one was at a greater risk for developing significant hyperbilirubinemia (Table 9).

<table>
<thead>
<tr>
<th>Table 4.9 Newborns readmitted for hyperbilirubinemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/19- 4/30</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>2011</td>
</tr>
<tr>
<td>2012</td>
</tr>
</tbody>
</table>

Limitations

The medical providers managing the care of the newborns in the nursery changed about seven weeks before the implementation of the AAP CPG in the nursery. In February 2012, the hospital contracted a new neonatology physician group to staff the neonatal intensive care unit. With this change, the pediatric hospitalists absorbed 45% of the healthy newborns previously managed by the neonatologists increasing their nursery coverage to greater than 90% of the newborns admitted to the nursery. Seven local pediatricians managed at least 5% of the newborns born in the hospital that were their private patients. There was a significant change between 2011 and 2012 in the medical providers that
medically managed the nursery. This factor may have had an effect on the changes noted in the medical management and treatment of both cohorts.

An unexpected but significant limitation was encountered when it became apparent that there was inadequate equipment available to adequately treat newborns with phototherapy as per the guidelines. Interestingly, newborns were being diagnosed and treated for hyperbilirubinemia in clusters. It is unclear why this was the case, but may require further study, but due to multiple newborns requiring simultaneous treatment, equipment was divided and shared among all of the newborns requiring treatment. This resulted in “inappropriate” (less intensity) treatment for some.
CHAPTER FIVE: CONCLUSIONS

Discussion

Nurses play the major role in assessing newborns for hyperbilirubinemia and determining the necessity for ordering further testing. The nurses on this unit have a new heightened awareness of when to evaluate newborns for jaundice through routine assessments and how to identity risk factors that may lead to severe hyperbilirubinemia. Nursing staff and management on this unit have a low turnover rate which allowed consistency in application of this practice change.

A nurse’s decision of when to obtain a TcB is now based on the nurses understanding of the unique importance of hyperbilirubinemia’s timing. The use of the new nursing algorithm based on the AAP guidelines, is being used to assist in decision making as to whether an immediate TcB is needed or whether it is judicious to continue to assess. The process changes that were initiated with the implementation of the AAP Hyperbilirubinemia CPG appear to have been significant in decreasing the number of TSBs obtained on newborns in the nursery.

Communication, a key component of the Model for Implementing EBP, among medical and nursing staff played a role in the integration and maintaining practice change. With the implantation of this CPG, a nursery newsletter was initiated initially to update nurses with the positive changes that occurred specifically after implementing the AAPs Hyperbilirubinemia CPG. This newsletter is currently being published every other month and has evolved into a tool to communicate information and unit policy updates for the nursing staff on the Mother-Baby Unit. The nursing and medical administrators started
distributing the newsletter to all of the maternal child health units and community pediatriicians to promote the positive care and changes in the nursery. Staff nurses are encouraged and have provided articles for the newsletter empowering nurses to have a say in the care they provide on a daily basis.

**Lessons Learned**

One of the identified barriers to the implementation of this project was working with the community pediatricians to follow the AAP Hyperbilirubinemia CPG. Although, they agreed with the written AAP guideline, three of the four newborns followed by the community pediatricians were not appropriately treated for hyperbilirubinemia based on the AAP guidelines. I reviewed each case then discussed the cases with the pediatricians, and the consensus with the pediatricians is that it is difficult to break “old habits” even when they are aware of the evidence. Continued case reviews and discussions need to continue to maintain the practice change.

**Cost Analysis**

Routine bilirubin screening at discharge is a recommendation of the AAP CPG. Obtaining an early bilirubin level often leads to frequent and unnecessary testing which can ultimately increase the cost of routine screening in the prevention of severe hyperbilirubinemia in newborns. All newborns are minimally screened for hyperbilirubinemia with one TcB during their birth hospitalization. At the Fredericksburg, VA hospital, approximately 40% of newborns, in both 2011 and 2012 received confirmatory TSB based on the TcB that is in the high intermediate or high risk zone on the AAP nomogram.
An estimated breakdown of the costs for obtaining TcBs and TSBs based on the data collected in this study (Table 1).

<table>
<thead>
<tr>
<th>Supplies</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCB Meter</td>
<td>$5000</td>
</tr>
<tr>
<td>TcB probe</td>
<td>$6 - $10</td>
</tr>
<tr>
<td>Heel Warmer</td>
<td>$2</td>
</tr>
<tr>
<td>TSB lab test</td>
<td>$25</td>
</tr>
<tr>
<td>Nurse’s Hourly Salary</td>
<td>$31</td>
</tr>
<tr>
<td>Lab Technician</td>
<td>$20</td>
</tr>
<tr>
<td><strong>Total TcB Cost</strong></td>
<td>$22</td>
</tr>
<tr>
<td><strong>Total TSB Cost</strong></td>
<td>$55</td>
</tr>
</tbody>
</table>

(Salary.com, 2012)

Based on an approximation of costs of supplies, nursing, and lab technician time, a TcB costs approximately $20-24 ($22 average) and a TSB is at least $50-60 ($55 average) per newborn. For baseline TcB screening, this equates to $66,000 per year if 3000 newborns are admitted to the newborn nursery at this hospital this year. Approximately 1200 (40%) newborns would require a confirmatory TSB measurement costing $66,000. The cost to test all newborns once with a TcB plus an additional 1200 (40%) with a single confirmatory TSB increases the total cost for bilirubin screening only to approximately $132,000 per year. Based on the 6 week TSB rates, in 2011 and 2012 there would be approximately 2097 and 1726 TSBs obtained on newborns respectively (Table 1).

<table>
<thead>
<tr>
<th>Year</th>
<th>Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>3000 deliveries per year x % TSBs (40.4%) x # TSB per NB (1.73) = 2097</td>
</tr>
<tr>
<td>2012</td>
<td>3000 deliveries per year x % TSBs (42%) x # TSB per NB (1.37) = 1726</td>
</tr>
</tbody>
</table>
If the all newborns receive one TcB and the TSB rates are similar to the ones from this study, there will be an overall saving of $20,405 for bilirubin testing with the implementation of the CPG in 2012 (Table 2).

<table>
<thead>
<tr>
<th>Year</th>
<th>Bilirubin Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>$115,335 + $66,000 = $181,335</td>
</tr>
<tr>
<td>2012</td>
<td>$94,930 + $66,000 = $160,930</td>
</tr>
<tr>
<td>Savings</td>
<td>$20,405</td>
</tr>
</tbody>
</table>

Treating newborns for the prevention of severe hyperbilirubinemia is an additional cost to the healthcare system, a cost that is mostly borne by the hospital itself. Phototherapy and additional hospital days are not reimburse by insurance companies but considered to be part of the bundled payments made for routine vaginal or cesarean deliveries regardless of the length of stay of either a mother and/or her newborn. Additional expenses likely include: an extended stay in the hospital, increased nursing hours to set up and monitor the equipment, monitoring the newborn receiving phototherapy, and obtaining additional TSBs. Five to ten percent of newborns are expected to be treated for hyperbilirubinemia during their birth hospitalization. Using the percentage of newborns treated over these two 6 week periods, in 2011 an estimated 201 (6.7%) newborns would have been treated with phototherapy for an approximate total of 4523 phototherapy hours. In 2012, a projected 174 (5.8%) newborns would be treated for an estimated total of 3480 hours. There is a projected estimate of 1043 fewer treatment hours on newborns in 2012 that may be associated with the implementation of the CPG. Using the average number of additional days required to treat newborns over the project periods, in 2011 there was an estimated 78 additional hospital
days for newborns requiring phototherapy. In 2012, there would be approximately 52 additional hospital days for newborns receiving phototherapy. This is a potential improvement of 26 fewer days in the hospital for newborns in the year 2012.

Summary

Standardizing clinical practice in the nursery by implementing the AAPs Hyperbilirubinemia CPG provided an opportunity to improve the quality of care for newborns in the nursery in the hospital in Fredericksburg, VA. The Model for Evidence Based Practice was the basis for implementing the CPG into practice allowing all stakeholders especially nursing to assume a pivotal role in the nursery’s practice change. Through this practice change, nurses gained a new sense of autonomy and self confidence in their ability to identify newborns at risk for hyperbilirubinemia. With the successful adoption of this CPG, nurses have brought forward other quality improvement initiatives for future projects to continue improving newborn care.

Continued data reviews and communication of the results post implementation of the CPG with key stakeholders throughout the hospital system will be critical to the continued adherence and further improvements to this project. Through using standardized guidelines, improvements in newborn care in the nursery has given nurses the opportunity to use their knowledge and assessment skills to make appropriate decisions in screening newborns for hyperbilirubinemia based on the AAPs guidelines. These changes have improved care and will ultimately decrease healthcare costs by minimally decreasing lab costs, nursing time, and newborn’s length of stay.
Recommendations

Late preterm newborns are known to be at increased risk for the development of severe hyperbilirubinemia than term newborns. After the implementation of the Hyperbilirubinemia CPG, the newborns readmitted to the hospital were mostly late preterm newborns whose bilirubin level often peaks 2-3 days after discharge. Is the discharge bilirubin level at 36-48 hours of life prior to discharge able to accurately predict the risk of late preterm newborns development of hyperbilirubinemia? Should the late preterm newborn have different recommendations and length of stay requirements to prevent readmissions? Reviewing the literature and in depth chart reviews on late preterm newborns may provide additional information that could lead to developing a change in nursery guidelines for this group of newborns.

With the implementation of this project, nurses have witnessed firsthand their ability to participate in a clinical practice change that has made a difference in their delivery of care. A decrease in TSBs and an increased use of appropriate phototherapy improved nursing and family satisfaction by decreasing painful heel sticks, allowing more time for maternal infant bonding, and supporting successful breastfeeding. Nurses are comfortable with discussing hyperbilirubinemia and treatment options with families due to the improved consistency in care.

As a result of this project, a team of key stakeholders (nurses, management, medical director, nurse practitioner) met to look at the nursery processes to make positive changes in the care of the newborns in the nursery. This group, now known as the clinical practice group, has continued to meet on a bimonthly basis to evaluate current processes, make changes as necessary and to address unit issues. These meetings generated the
Nursery Newsletter to disseminate information to the nursing staff, initially on the Hyperbilirubinemia CPG, but have continued to be published every other month with educational articles that highlight pertinent clinical information. Nurses have used these meeting to work together on improving patient care and to suggest future initiatives that will continue to look at evidence based practices for implementation in the nursery. Nurses are more confident in the care they provide the newborns and families. Continuing these meetings and the Nursery Newsletter is a key component in maintaining this practice change. Additionally, it is important to share the results with other colleagues through Grand Rounds, hospital committee meetings, and submission for publication.
APPENDIX A

NURSE HYPERBILIRUBINEMIA ALGORITHM
Nurse Algorithm
Visually Assess Newborn for Jaundice with Routine Vital Signs

- NB appears jaundiced in 1st 24 hrs of life.
  - Yes: Check TcB Confirmed w/ TSB if in high intermediate or high risk zone* → Notify Provider if TSB > 5
  - No: NB jaundice appears excessive based on hours of life
    - Yes: Check TcB Confirmed w/ TSB if in high intermediate or high risk zone* → Notify Provider if TSB - High Intermediate risk zone* or higher with risk factors
    - No: NB appears jaundiced with significant risk factors for developing severe hyperbilirubinemia
      - Yes/Unsure: Check TcB on day of discharge. Confirm w/ TSB if in high intermediate or high risk zone* → Notify Provider if TSB - High Intermediate risk zone* or higher with risk factors
      - No: NB ready for discharge home
        - Yes: Check TcB on day of discharge. Confirm w/ TSB if in high intermediate or high risk zone* → Notify Provider if TSB - High Intermediate risk zone* or higher with risk factors
        - No: Reassess for jaundice w/ routine vital signs

* See AAP hour specific nomogram.
APPENDIX B

HYPERBILIRUBINEMIA RISK FACTOR TOOL
Hyperbilirubinemia Risk Factor Tool

Significant Risk Factors for Hyperbilirubinemia

* Lower gestational age < 38 weeks
* Jaundice observed in 1st 24 hrs
* Iso-immune or hemolytic disease (G6PD, Coombs +)
* Pre-discharge TSB measurement in high risk zone
* Exclusively Breastfed and not nursing well
* Cephalhematoma or significant bruising
* Previous sibling with jaundice
* East Asian race
* Most significant for causing severe hyperbilirubinemia

Hour Specific Nomogram for Phototherapy

* Use total bilirubin. Do not subtract direct reacting or conjugated bilirubin.
* Risk factors = isoimmune hemolytic disease, G6PD deficiency, asphyxia, significant lethargy, temperature instability, sepsis, acidosis, or albumin < 3.0g/dL, (if measured)
* For well infants 35-37 6/7 wk can adjust TSB levels for intervention around the medium risk line. It is an option to intervene at lower TSB levels for infants closer to 36 wks and at higher TSB levels for those closer to 37 6/7 wk.
* It is an option to provide conventional phototherapy in hospital or at home at TSB levels 2-3 mg/dL (35-50mmol/L) below those shown but home phototherapy should not be used in any infant with risk factors.
APPENDIX C

GENERAL GUIDELINES
General Guidelines

1) All newborns born to mothers with the blood type O or Rh Negative will automatically have the cord blood sent for blood type, direct antibody testing (DAT/Coombs testing), and cord bilirubin level.

   a) Newborns that are Coombs positive will have a TSB drawn at 6 hours of life. Follow up levels will be determined based on the 6 hour bilirubin and newborn risk factors.

2) Jaundice will be assessed on all newborns routinely with vital signs.

   a) If newborn is determined to be jaundice on a routine assessment, nurses will follow the algorithm to determine the need to obtain a bilirubin measurement.
   b) If the newborn appears jaundice in the first 24 hrs of life, a TcB/TSB should be drawn.
   c) If the NB appears excessively jaundice based on the hours of life or if unsure, a TcB/TSB should be drawn.

3) All breastfeeding mothers will be evaluated by a lactation consultant during their birth hospitalization, regardless of their previous breast feeding experience.

   a) Mothers who breastfeed will be encouraged to breastfeed every 2 hours or at least 8-12 times per day.
   b) Breastfed newborns determined to have significant weight loss (>4% per day or >8% on day of discharge) and/or thought to be breastfeeding poorly will be priority patients for lactation to evaluate in the morning.

4) All newborns before discharge should have a risk assessment performed for the development of severe hyperbilirubinemia.

   a) Major Risk Factors.
      • Pre-discharge TSB/TcB level in the high-risk zone on the hour specific nomogram
      • Jaundice observed in the first 24 hr of life
      • Blood group incompatibility with positive direct antibody test
      • Known hemolytic disease (e.g., G6PD deficiency)
      • Gestational age 35–36 wk
      • Previous sibling received phototherapy
      • Cephalhematoma or significant bruising of the newborn
      • Exclusive breastfeeding, specifically if newborn is nursing poorly or has an excessive weight loss.
      • East Asian race
b) Minor Risk Factors.
   - Pre-discharge TSB/TcB level in the high intermediate-risk zone on the hour specific nomogram
   - Gestational age 37–38 wk
   - Jaundice observed before discharge
   - Previous sibling with jaundice
   - Macrosomic infant of a diabetic mother
   - Maternal age
   - Male gender

c) Decreased Risk Factors.
   - TSB or TcB level in the low-risk zone
   - Gestational age 41 wk
   - Exclusive bottle feeding
   - Black race
   - Discharge from hospital after 72 h

5) Newborns determined to have significant hyperbilirubinemia based on the bilirubin level plotted on the hour specific nomogram will then be evaluated for phototherapy or close follow up with their primary care provider.
   
a) If the newborn requires treatment based on the phototherapy hour specific nomogram, then newborn will receive intense phototherapy, with repeat TSB levels obtained 6-12 hours after initiation of phototherapy.

6) All newborns require evaluation by the newborn’s primary care provider within a few days of discharge.
   
a) All newborns d/c before 72 hours of life should be seen within 48 hours of discharge.
   b) Newborns at that have risk factors for the development of hyperbilirubinemia should follow up sooner with their primary care provider.
   c) All newborns regardless of risk factors can develop hyperbilirubinemia.

7) Parents will be given information upon discharge on the evaluation of hyperbilirubinemia.

**Appendices B and C**

Data Collection

MR #:______________________________

Sex:  Male _________  Female _______

Gestational age (wks): __________

Maternal Blood Type: _________  Newborn’s Blood Type: _________  N/A _____

Coombs:  Positive______  Negative______  N/A_____

Bilirubin Level: ____________  Age in Hours: ____________

Phototherapy:  Yes____  No____  Duration in hours: ____________

# of lights used to treat __________

Risk Zone at Treatment:  High_____  High Intermediate_____  Low Intermediate_____

Number of Bilirubin Tests obtained during Hospitalization:

TcB _________  TSB___________

Hospital Readmission in 7 days:  Yes_____  No_____
Hyperbilirubinemia Risk Factors

**Major risk factors**

- Pre-discharge TSB or TcB level measuring in the high-risk zone
- Jaundice observed in the first 24 hr of life
- Blood group incompatibility with positive direct antiglobulin test (ABO or Rh incompatibility with Coombs + results)
- Known hemolytic disease (e.g., G6PD deficiency)
- Elevated ETCOc
- Gestational age 35–36 wk
- Previous sibling received phototherapy
- Cephalhematoma or significant bruising of the newborn
- Exclusive breastfeeding, specifically nursing poorly or an excessive weight loss
- East Asian race

**Minor risk factors**

- Pre-discharge TSB or TcB level measuring in the high intermediate-risk zone
- Gestational age 37–38 wk
- Jaundice observed before discharge
- Previous sibling with jaundice
- Large infant of a diabetic mother
- Maternal age
- Male gender

**Decreased risk factors**

- TSB or TcB level measuring in the low-risk zone
- Gestational age 41 wk
- Exclusive bottle feeding
- Black race
- Discharge from hospital after 72 h

References


