

Implementation and Evaluation of “Golden Hour” Practice

in Infants Less Than 33 Weeks Gestation

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Prematurity is a leading cause of infant mortality. The cost of care for infants born prematurely in the United States is over \$26 billion dollars annually (Dezen & Lynch, 2010).

The March of Dimes (MOD) 2010 perinatal statistics shows that Nebraska had a premature birth rate of 11.9% of all live births. In other words, 62 babies are born premature each week with nine of the 62 births being born classified as very premature (March of Dimes, 2010).

Prematurity is associated with long-term morbidities that include chronic lung disease (CLD), neurodevelopmental impairments (cognitive and motor delays), and visual disturbances (Center for Disease Control, 2010).

In an effort to reduce long-term morbidities associated with prematurity, the Vermont Oxford Network (VON) formed a collaborative to evaluate potentially better practices (PBP). One of the focuses of the PBP was to minimize stress in infants at birth and during the first hour of life (Sharek et al., 2003). They coined this time “the golden hour”, taken from the adult trauma treatment arena in which the best timeframe to prevent irreversible internal damage and optimize the chance of survival is most effective (Frndak, 2010; Merriam-Webster, 2010).

Neonatal resuscitation techniques are needed in approximately 10% of all term births (Perlman, et al, 2010). The more premature the infant is at birth, the greater the need for neonatal resuscitation measures to achieve extrauterine stability. Consistencies in delivery room stabilization practices have been shown to improve patient care outcomes (American Heart Association/American Academy of Pediatrics [AHA/AAP], 2006; Karlsen, 2006; Keszler, 2010). According to Keszler (2010), to successfully transition from intrauterine life to extrauterine life, the infant must establish functional residual capacity in the lungs through initial ventilations,

increase pulmonary blood flow, and achieve adequate tissue oxygenation levels. This requires a clear airway, adequate respiratory effort, sufficient surfactant (or positive end expiratory pressure [PEEP] that supports surfactant production), normal pulmonary vascular response, adequate cardiac function, and adequate neuromuscular function.

Neonatal golden hour stabilization practices focus on techniques that support infant transition to extrauterine life: applying evidence-based practices to improve quality of care, providing consistent care, minimizing complications, and improving teamwork (Reynolds, Pilcher, Ring, Johnson & McKinley, 2009). Techniques included in the golden hour stabilization practices are administering PEEP, continuous positive pressure ventilation (CPAP), nasal ventilator strategies to an infant in the delivery room to reduce intubations, identifying early those infants who need surfactant administration, oxygen targeting and thermal management (Goldsmith, 2009; Keszler, 2010). Although golden hour stabilization practice is recommended with identified techniques, no clear delivery room golden hour practice protocol have been established due to variances in research and variances in implementation in delivery room practices.

Problem & Significance

Neonatal nurse practitioners (NNPs) are the primary high-risk delivery room care managers in many metropolitan hospitals with level III neonatal intensive care units (NICUs). The NNPs have a role in overseeing delivery room management of at-risk infants and ensuring that evidenced based practices are carried out to optimize long term outcomes for infants, particularly very low birth weight (VLBW) infants. The VON identifies VLBW infants as those infants born before the completion of 32 weeks gestation or with a birth weight of 1500 grams or less. Inquiry of NNPs (N=10) working within a Midwest level III metropolitan hospital

confirmed inconsistencies with delivery room practices. Delivery room decision-making varied based on maternal history, infant gestation, infant presentation, clinical assessment of mom and baby, clinical skills of the NNP and the NNP's level of experience. Neonatologists covering the NICU also influence NNP delivery room decisions. The neonatology group consists of six neonatologists with varying backgrounds and differences in practice. During the NNP inquiry, differences in delivery room management showed inconsistencies in delivery room stabilization practice even when given the same scenario. The variations in NNPs delivery room stabilization practices were based on differences in clinical assessment, interpretation of heart rate and color and attending neonatologist. These assessment criteria, particularly color, have been questioned as to their reliability and accuracy (Bismilla et al., 2010; Leone, Rich, & Finer, 2006; O'Donnell, Kamlin, Davis, & Morley, 2006; Wood et al., 2008). In addition, NICU RNs who attend deliveries with the NNP voice frustrations about the variations in the NNPs delivery room management practices.

Neonatal lung function changes immediately upon delivery to the extrauterine environment. Delivery room management, particularly in the preterm infant, affects these changes both positively and negatively. Lung tissue function can be altered within the first few breaths based on delivery room management (Halamek & Morley, 2006; Rojas et al., 2009). These delivery room care practices are contributing factors to long-term infant development and influence the incidence of chronic lung disease (CLD) (Baumgart, 2008; Dawson, Davis, O'Donnell, Kamlin, & Morley, 2007; Holtsclaw, 2008; Laughon et al., 2009; Reynolds et al., 2009; Vento et al., 2009).

According to VON data for this Midwest level III NICU where the NNP inquiry occurred, the incidence of chronic lung disease is higher than similar VON network sites. A plan

was therefore needed to decrease CLD in the NICU. It has been established that respiratory initiation and stabilization are essential in delivery room management and there are inconsistencies within the current NNPs delivery room practices. The use of CPAP has been shown to increase lung volumes, thereby improving lung expansion, increasing functional residual capacity (FRC), improving ventilation-perfusion mismatch, decreasing pulmonary vascular resistance and improving oxygenation (Finer et al., 2004; Halamek & Morley, 2006; Pillow et al., 2007). According to the VON data for this Midwest NICU, the use of CPAP before intubation is minimally provided to infants less than 33 weeks (see Table 1).

Positive pressure ventilation (PPV), if unmonitored, has been associated with detrimental outcomes including pneumothoracies, volume trauma, and subsequent release of cytokines that alter lung function (Hillman et al., 2007). In this NICU, a self-inflating bag and mask, a flow-inflating bag, or a T-piece resuscitation device had been used to provide PPV depending on the neonatologist or NNP's preference.

Oxygen toxicity, levels of oxygen in the body exceeding the tissue perfusion needs, increases the risk for CLD (Dzietko et al., 2008; Gerstner et al., 2007). Research shows that hypoxia and hyperoxia lead to release of free radicals with subsequent tissue injury (Finer & Leone, 2009; Finer, Saugstad et al., 2010). Delivery room management among the neonatologist and NNPs in this Midwest level III NICU varied in the concentration of oxygen given to low birth weight infants at birth. The fraction of inspired oxygen (FiO₂) concentration ranged from 0.4-1.0 and weaned based on the infant's color. Application of pulse oximetry monitoring immediately upon placing an infant on a radiant warmer (bed) after birth would minimize damage caused by oxygen toxicity. The 2010 NRP recommendations include application of pulse oximetry monitoring in the delivery room to increase accuracy of heart rate and oxygen

saturation levels that could guide oxygen delivery. Studies have shown inaccuracies with clinical interpretation of color and heart rate when compared to pulse oximetry readings (Dawson et al., 2007; Elliott, Tate, & Page, 2006; Vento et al., 2008). Practice among this NNP group regarding application of pulse oximetry and adjusting the oxygen concentration delivered to maintain the pulse oximetry readings within a certain range (oxygen targeting) typically began on admission to the NICU, not in the delivery room. According to the NNP inquiry, application of pulse oximetry was often an afterthought and initiated only after other stabilization techniques had been completed. The VON data showed high usage of oxygen in delivery room management (see Table 1).

Thermal instability has a detrimental effect on infants' transition to extrauterine life. There were no consistent practices on thermal management between the NNPs or NICU RNs in this Midwest NICU. The VON 2008 data for this Midwestern NICU showed that admission temperatures for infants born less than 33 weeks gestation and less than 1500 grams were euthermic less than 11% of the time (see Table 1). The NNP group investigated potential reasons for thermal instability in 2009. Practice changes were suggested for infants born before 34 weeks gestation and included 1) the increase in the delivery room temperature, when time permits, to 74 degrees, 2) the use of a chemical mattresses, and 3) to place infants up to their neck into a polyurethane bag immediately after delivery. These practices, when implemented, have helped reduce the incidence of thermal instability; however, infants admitted with euthermic temperature ranges remain below 40% according to VON data (see Table 1).

Vermont Oxford Network data for this metropolitan hospital showed high rates of delivery room intubations, high use of supplemental oxygen in the delivery room, minimal use of CPAP prior to intubation, and problems with thermal regulation in the delivery room and upon

admission to the NICU. The inquiry of NNPs, as well as the VON data, confirmed inconsistencies within this group with compliance of “golden hour” practices to infants born before the completion of 33 weeks gestation.

The purpose of this project was to evaluate methods that could potentially reduce the incidence of CLD, format an educational plan, disseminate the information, and then evaluate compliance with the established protocol. This education plan was provided to medical personnel as a way to provide consistency in delivery room management of infants < 33 weeks gestation focusing on providing an inspiratory hold, early PEEP, limiting oxygen exposure, maintenance of a eutermic environment, guidelines for delivery room surfactant administration with guidelines for early extubation and teamwork. Practice protocols/guidelines were established for decision making on intubation, surfactant use, and extubation criteria (if intubated in delivery room).

The final component of this project was to monitor compliance of the NICU team with the practice changes. In assessing compliance, barriers to compliance can be identified and remedied. The research questions for this project are:

- 1) What is the NICU team overall compliance rate with “golden hour” practice?
 - What are the compliance rates for respiratory components of the “golden hour practice?
 - What are the compliance rates for oxygen exposure?
 - What are the compliance rates for thermal management components of the “golden hour practice?
- 2) What are the barriers to implementation of “golden hour” stabilization practices?

3) Does NICU team compliance with delivery room “golden hour” stabilization practices improve long-term outcomes for infants born less than 33 weeks gestation, specifically the incidence of CLD?

Conceptual Framework and Models

This quality improvement project for the development and implementation of the “golden hour” stabilization practices was guided by the use of *Neuman’s Systems Model* (NSM), *Clinical Excellence through Evidence-Based Practice* model (CETEP), and the “Golden hour” principles. The infant is at the center of all NICU teams just as the stable infant is the core of the NSM (see Appendix A). Interventions can have a positive or a negative effect on the infant. The goal of the NICU team is to help the infant transition from intrauterine life, adapt to extrauterine life, and maintain organ system stability that facilitates optimal growth and development. This is no easy feat for the very low birth weight infant.

To obtain a better understanding of the stabilization process, the NSM was utilized. Neuman’s System Model is based on a holistic approach to protect and promote the welfare of the client (Neuman, 1995; Walker, 2005).

The NSM is an open systems model that views nursing as being primarily concerned with defining appropriate action in stress-related situations or in possible reactions of the client/client system; since environmental exchanges are reciprocal, both client and environment may be positively or negatively affected by each other (Neuman, 1995, p. 11).

The NSM identifies the goal as maintaining client stability. Clients are active participants in their internal and external environment; “the client is in constant change, with reciprocal environmental interactions” (Neuman, 1995, p 12) in which they move toward

stability and wellness or toward illness of varying degrees. Stressors are forces that produce tension within the internal and/or external environment of the client. The flexible line of defense protects the normal line of defense, which is the usual state of wellness in the client. The area of resistance and the degree of reaction are the client's response reactions to the stressors. How the client can protect, maintain or adjust to the stressors that they encounter is also part of the area of resistance.

The NICU team goal is to facilitate optimal wellness for the client through retention, attainment, or maintenance of client system stability. Purposeful interventions can help clients attain and maintain stability. Primary prevention interventions are those actions that would maintain the stable state and reduce encounters with stressors. Primary prevention interventions would help strengthen the flexible line of defense. For example, a prevention method to stop premature delivery is one example of primary prevention. Another example would be the administration of antenatal steroids to the mother, to boost the infant's immune response. The implementation of evidence-based respiratory support is an example of a primary prevention intervention. Secondary prevention methods are those interventions that are put into place to prevent continued stress responses or to help stabilize the infant after exposure to a stressor. Secondary prevention interventions attempt to identify the stressor and treat symptoms at the earliest possible moment in an attempt to return client stability. Tertiary prevention interventions are strategies to help minimize the damage caused by the stressors, and to help the client readapt. The "golden hour" principles can be categorized as both primary and secondary prevention methods.

Utilization of the CETEP model guided this quality improvement project. The CETEP model consists of five processes

1. Define the clinical practice question,
2. Assess the critical appraisal components,
3. Plan the implementation,
4. Implement the practice change, and
5. Evaluate the practice change (Collins et al., 2007).

The clinical practice question was identified from the VON data (step 1). Through the CETEP model, the second step of critical appraisal was to evaluate research of potential causes of CLD and evidence-based practices to reduce the incidence of CLD. This appraisal process led to the decision to promote “golden hour” stabilization practices.

The “golden hour” stabilization practices provided a model for implementation because the focus is on specific processes to stabilize the infant. These processes include teamwork, consistency in care, minimizing complications, maintenance of patent airway, providing respiratory intervention that improves the infant’s functional residual capacity, minimizing oxygen exposure, and maintenance of infant thermal stability.

Literature Review

First Breaths of Life

The transition to neonatal life begins in utero with the onset of labor, when mobilization of lung fluids begins. After delivery, the infant must continue to mobilize lung fluids, inflate the airways and alveoli, decrease pulmonary vascular resistance, and increase peripheral vascular resistance (MacDonald, Mullett & Seshia, 2005). Term infants are able to achieve this with crying. The VLBW infant, however, is impaired in this transition due to the immature structure of the chest wall and lungs. Surfactant, a protein substance that helps sustain compliance of the lungs, is lacking in quantities sufficient for maintaining airway integrity. Surfactant is readily

depleted in the VLBW infant; therefore respiratory support methods were needed. The methods of providing respiratory support in the delivery room for VLBW infants at this metropolitan hospital included ventilating with a self-inflating bag, flow-inflating bag, or T-piece resuscitation device. All three devices have a pressure manometer. The flow-inflating bag and T-piece resuscitation devices also have a method to provide PEEP. Only the T-piece resuscitation device had set controls to provide consistent inspiratory pressure and PEEP, which help minimize lung injury.

Lung injury can occur due to atelectrauma, volutrauma, barotrauma, and biotrauma (Cannizzaro, Berry, Nicholls, Hantos & Sly, 2010; Clark et al., 2001; Goldsmith, 2009; Loring et al., 2010; Snyder, Walker & Reese, 2010). Atelectrauma is caused by mechanical shear stress to the lung tissue when the alveoli sacs are recruited but then collapse during the breathing cycle. Methods to reduce atelectrauma include recruitment maneuvers (inspiratory hold and PEEP), optimizing the functional residual capacity (FRC) of the lung, and high frequency mechanical ventilation (Barbas, 2010; Clark et al., 2001; Santiago et al., 2010).

Volutrauma is excessive stretching of the lung tissue cause by aggressive positive pressure ventilation. Barotrauma is the combination of fluid overload, high ventilation pressures, and pulmonary air leak (Dreyfuss & Saumon, 1992; Van Marter et al., 2000). Volutrauma and barotrauma can be reduced by avoiding high airway pressures and large lung volumes. Ventilatory methods that reduce lung injury, include providing CPAP, low tidal volumes, inspiratory pressures that adequately inflate the lungs without overdistension, but assist in the evacuation of lung fluid. These methods will optimize FRC and will reduce volutrauma and barotrauma (Aly, 2009; Clark et al., 2001; Loring et al., 2010).

Biotrauma is the release of free radicals and cytokines that alter the interstitial tissue of the lung thereby altering lung function (Cannizzaro et al., 2010; Thomson et al., 2006).

Reduction in biotrauma includes all components that reduce the inflammatory markers, cytokines, and free radicals that alter lung function.

Review of the literature in chronologic order reveals the VON program was the first to identify potentially better practices that included promotion of CPAP for initial stabilization in selected infants and minimizing the duration of mechanical ventilation by promoting early extubation. Finer et al. (2004) explored the use of CPAP in the respiratory care management of infants since the 1970's. They demonstrated that CPAP started within minutes to hours after delivery reduced the use of mechanical ventilation without increasing other morbidities. Several investigators have compared the use of nasal CPAP (NCPAP) to intubation and surfactant therapy. Aly, Massaro, Patel and El-Mohandes (2005) stratified 234 infants with gestational age less than 30 weeks into four groups. Group one infants were supported with early NCPAP (5 cm water pressure) in the delivery room. Group two infants began with early NCPAP, but required intubation during the first week of life. Group three infants were intubated in the delivery room, but transitioned successfully to CPAP within the first 48 hours and were treated with CPAP for the first week of life or longer. Group four infants were intubated in the delivery room and treated with intermittent mechanical ventilation for greater than 48 hours. Early NCPAP was implemented successfully in the delivery room for 151 infants. Infants who required intubation had significantly lower gestational age, birth weight, and 1-minute Apgar scores than infants not requiring intubation. Infants less than 24 weeks gestation were unable to maintain adequate ventilations on early NCPAP alone. The authors found that infants who were intubated briefly in the delivery room were at increased risk for prolonged oxygen requirements. They concluded

that an individualized approach to delivery room management should be considered for VLBW infants with early NCPAP as a primary option.

Animal studies began to be published that provided valuable information regarding the safety of pressure in ventilator management. Flecknoe et al. (2007) evaluated the use of PEEP in newborn lambs. They found that ventilating lambs with 10 cm water pressure as PEEP increased end-expiratory lung volumes, which lead to increased lung growth in mechanically ventilated two week-old lambs but did not alter the proportions of alveolar epithelial cell. Summation of their study is that PEEP stimulates lung growth, does not cause damage, and surfactant protein expression was not reduced. Loring et al. (2010), in their work with rats, confirms that a PEEP of 6-11 cm water pressure in acute lung injury prevents proinflammatory cytokines and mediator release, pulmonary edema, and mechanical abnormalities. The identification of a safe positive pressure range using CPAP and PEEP lends to the efficacy for exploration of other ventilation management modalities.

Studies looked at neuroprotective effects of NCPAP and the impact it has on necrotizing enterocolitis. In the COIN trial, Morley et al. (2008) evaluated infants on NCPAP born between 25 and 28 weeks gestation that were randomized to either NCPAP or intermittent positive pressure ventilation (IPPV). There was no significant difference in neurodevelopment between NCPAP and IPPV infants at one year of age. Aly, Massaro, Hammad, Narang, and Essers (2009) evaluated the use of NCPAP and the development of necrotizing enterocolitis (NEC). They found that the risk of NEC in VLBW infants did not increase with the use of NCPAP.

Rojas et al. (2009) studied NCPAP versus surfactant in their randomized control trial of 279 infants between 27 and 31 weeks gestation. Infants in the treatment group received very early surfactant administration, extubation (within the first hour of life) and NCPAP whereas

infants in the control group received NCPAP at 6 cm water pressure. Results from their trial showed that the treatment group had lower need for mechanical ventilation, less air-leak syndromes, received less surfactant after the first hour of life, and had a 10% less incidence of chronic lung disease.

Researchers in the SUPPORT Study (Finer, Waldemar et al., 2010) were also comparing CPAP with surfactant. This multi-center randomized controlled trial involved 1,316 infants born between 24 weeks and 27 6/7 weeks gestation. Infants were randomly assigned to intubation and surfactant within one hour after birth or to CPAP (8 cm water pressure) treatment initiated in the delivery room. There were protocol-driven limited ventilation strategies. Results of the study showed that infants who received CPAP treatment, when compared to the infants who received surfactant, had less need for intubation. The CPAP group had decreased need for postnatal corticosteroids for bronchopulmonary dysplasia, required fewer days of mechanical ventilation, and was more likely to be alive and free from the need for mechanical ventilation by day seven of life. No differences in other adverse neonatal outcomes were noted.

These studies show that the use of CPAP in infants less than 33 weeks gestation have benefits. Benefits of CPAP include improvement in oxygenation, improvement in lung expansion, maintenance of lung volumes, increased FRC, improvement in ventilation-perfusion matching, decreased pulmonary vascular resistance, decreased atelectasis, lower upper airway resistances, and reduction in apnea of prematurity (De Paoli, Morley, & Davis, 2005; Halamek & Morley, 2006; Loring et al., 2010; Qian et al., 2008).

Clinical applications similar to “golden hour” practices were performed by Birenbaum et al. (2009), who implemented a quality improvement project to reduce the incidence of CLD. Changes to their practice included oxygen targeting with an oxygen saturation range of 88-92%,

selective intubation policy for infants delivered less than or equal to 29 weeks gestation, introduction of NCPAP 5 cm water pressure to spontaneously breathing infants equal to or greater than 27 weeks gestation, and use of a T-piece resuscitation device in the delivery room. The results of their quality improvement project showed a significant reduction in mechanical ventilation in the first 72 hours of life or at any time during the infant's hospitalization. Furthermore, they showed a reduction in the number of surfactant doses required, a significant improvement in daily weight gain during the first 28 days of life, a significant reduction in the incidence of CLD, and a reduction in the number of infants discharged home on oxygen therapy.

Multiple research and clinical trials have been completed to evaluate the optimal respiratory support for VLBW infants in the delivery room to reduce CLD without other long-term sequelae (De Paoli, Davis, Faber, & Morley, 2008; Diblasi, Zignego, Smith, Hansen, & Richardson, 2010; Finer et al., 2004; Pfister & Goldsmith, 2010). A common factor that arises from review of the reports of these trials is the initiation of CPAP shortly after birth. CPAP stabilizes lung inflation at the end of expiration and allows the next breath to further recruit lung volume and improve gas exchange. Nasal ventilation has been shown to be a viable option. Snyder, et al. (2010) found that infants born at the lowest gestation age of viability are at increased risk for respiratory failure. These infants benefit from the InSurE (*intubation-surfactant-extubation*) method (Cherif, Hachani & Khrouf, 2008; Rojas et al., 2009; Sekar & Corff, 2009; Stevens, Blennow, Myers & Soll, 2008; Van den Berg, Lemmers, Toet, Klaessens, & van Bel, 2010).

The research points to benefits of early implementation of PEEP to VLBW infants through CPAP devices to reduce the potential for long-term negative outcomes. Further benefits

of specific delivery room respiratory management strategies such as surfactant administration help reduce the incidence of CLD.

Oxygen Targeting

Oxygen has always been one of the most readily available and most liberally used medicines in the neonatal field. The NRP program provides guidelines for delivery room management and, until recently, has recommended 100% oxygen delivery to infants within the first moments after birth to assist in the transition from intrauterine to extrauterine life. The VON, through their Neonatal Intensive Care Quality Improvement Collaborative effort, targeted oxygen usage for one of their initiatives to improve neonatal outcomes (Sharek et al., 2003). Studies have linked hyperoxia or oxygen toxicity to a variety of negative consequences including retinopathy of prematurity (ROP), CLD, and long-term neurodevelopmental complications (Burch et al., 2003; Gerstner et al., 2007; Kaindl et al., 2008; Payne et al., 2006; Tin & Gupta, 2007).

Fetal development of eyes and brain are affected by oxygen-regulated vascular endothelial growth factor and non-oxygen regulated insulin-like growth. In utero, the arterial oxygen pressure of the fetus is 22 to 24 mmHg (Chow, Wright & Sola, 2003). After delivery, administration of supplemental oxygen can set the stage for vaso-obliteration of existing vessels and arrest the vascularization in the eyes, setting the infant at potential risk of ROP. It is thought that these same growth factors have similar effects on the developing brain tissue leading to alterations in cortical vascularization and cellular differentiation. Tin & Gupta (2007) found that hyperoxia doubled the incidence of periventricular leukomalacia and, subsequently, the development of cerebral palsy in preterm infants.

It is well known that oxygen itself can cause damage to normal lung tissue. Even if the oxygen concentration is not high, alterations in lung tissue occur because of oxidative stress (Pfister & Goldsmith, 2010). The propensity of premature infants to oxidative stress damage is higher because of the reduced antioxidant defenses, more free radical ions, and the higher risk of exposure to high oxygen concentrations (Askie, Henderson-Smart, Irwig & Simpson, 2003; Ellsbury & Ursprung, 2010; Tin & Gupta, 2007; Vento et al, 2009).

The NRP steering committee amended recommendations for oxygen usage in the delivery room based on the VON potentially better practice focus groups and the research studies evaluating oxygen usage. The committee now suggests starting the administration of oxygen between 30 and 90% and placing a pulse oximetry probe on the newborn infant to titrate the oxygen delivery to achieve appropriate saturation levels. Providing room air in the delivery room management of infants is also an acceptable means of neonatal resuscitation if oxygen is not available (AHA/AAP, 2006). Studies of the normal physiologic process after birth in healthy infants show oxygen saturations in the first minutes after birth can be as low as 60 to 70% and that it can take up to ten minutes for these infants to reach a stable oxygen saturation level (Askie et al., 2003; Nuntnarumit, Rojnueangnit & Tangnoo, 2010; Saugstad, 2010). Dawson et al. (2010) described the oxygen ranges for newborn infants within the first ten minutes of life during normal transition. The median amount of time for all infants to reach an oxygen saturation of equal to or more than 90% was 7.9 minutes. Recognition of the oxygen transitional phase in infants after delivery has led the NRP steering committee to add a ledger to the stabilization flow chart, describing the targeted preductal SpO₂ range after birth.

Several studies have evaluated delivery room resuscitation with room air versus oxygen with no difference in short- or long-term outcomes (Escrig et al., 2008; Martin et al., 2008;

Obladen, 2009; Saugstad, 2010; Saugstad et al., 2003; Saugstad, Rootwelt & Aalen, 1998; Vento, Sastre, Asensi & Vina, 2005). According to research, if the VLBW infant's oxygen saturation readings are not increasing by three to five minutes of life, then supplemental oxygen, titrated to maintain the saturations within a range of 85 to 95% could be beneficial (Chow et al., 2003; Ellsbury & Ursprung, 2010; Goldsmith, 2009; Reynolds et al., 2009; Saugstad, 2010; Tin & Gupta 2007; Vento et al., 2009).

Oxygen is a medicine and, as with any medicine, there are risks and benefits. There is accumulating evidence that suggests that the initial use of 21% versus 100% oxygen for resuscitation is associated with a significant lowering of mortality (Saugstad, Ramji & Vento, 2005; Tan, Schulze, O'Donnell & Davis, 2009). Supplemental oxygen usage to VLBW infants should be evaluated on an individual basis with specific guidelines for implementation and withdrawal.

Thermal Regulation

The goals of thermoregulation is to maintain correct body temperature range to maximize metabolic efficiency, reduce oxygen usage, protect enzyme function, and reduce caloric expenditure (Aylott, 2006a; MacDonald et al., 2005; Sola, Rogido & Partridge, 2002).

Maintenance of body temperature is a major task for all infants. Infants lose heat easily and have limited ability for heat production. VLBW infants are at risk for heat loss due to their large body surface area, limited development of the epidermal layers of the skin, superficial vasculature, limited brown adipose tissue deposits, poor glycogen stores, high body water content, and poor tone with decreased ability to maintain flexion (Gomella, Cunningham & Eval, 2009; Karlsen, 2006; MacDonald et al., 2005; Sola et al., 2002). Thermal regulation is controlled by the hypothalamus. The stimulated hypothalamus activates norepinephrine release that affects

pulmonary and peripheral vasculature and stimulates glycolysis. Normally, glycolysis occurs through an aerobic process, but VLBW infants readily convert glycogen to glucose via an anaerobic process when the infant is stressed. Anaerobic metabolism quickly consumes the glycogen and brown fat stores of these VLBW infants and increases the metabolic demand placed on the brain, heart, and adrenal glands, which will then alter their functioning and affect other organ systems (Aylott, 2006b; Baumgart, 2008; Karlsen, 2006; Knobel & Holditch-Davis, 2007). In addition to increased brown fat metabolism, some of the effects of hypothermia and hyperthermia include increased oxygen consumption, increased surfactant consumption with decreased surfactant production, hypoxia, persistent pulmonary hypertension, respiratory distress, increased circulating catecholamines, increased fatty acids, metabolic acidosis, hypoglycemia, apnea, cyanosis, tachycardia, bradycardia, arrhythmias, and poor weight gain (Baumgart, 2008; Gomella et al., 2009; Holtsclaw, 2008; Knobel & Holditch-Davis, 2007; MacDonald et al., 2005; Sola et al., 2002).

There are four core measures of heat transfer: convection, radiation, conduction, and evaporation. Convective heat loss occurs when airflow carries heat away from the body. Radiation is heat being exchanged between two objects that are not in direct contact with each other. Conduction is heat exchange that occurs between objects that are in direct contact with one another. Evaporation occurs when liquid is turned to vapor (Bhatt et al., 2007; Gomella et al., 2009; Horns, 2002; Mance, 2008). Recognition of the methods of heat transfer with intervention strategies to maintain a eutermic infant during the “golden hour” will facilitate the infant transition from intrauterine to extrauterine environment, thereby, maximizing metabolic efficiency and oxygen usage (Bissinger & Annibale, 2010; Knobel & Holditch-Davis, 2007; Sherman, Greenspan, Clair, Touch & Shaffer, 2006). One such method of thermal regulation is

to prewarm the delivery room, which benefits the VLBW infant and the mother (Dennison, 1995). Other VLBW infant thermal management practices include: preheated radiant warmers, polyethylene bags or wraps, portable chemical warming mattresses, warmed blankets, warmed gas for resuscitation, placement of hats on the infant's head, and preventing drafts around the bedside (Bhatt et al., 2007; Bredemeyer, Reid, & Wallace, 2005; Duman, Utkutan, Kumral, Köroğlu, & Özkan, 2006; Knobel & Holditch-Davis, 2007; Mance, 2008; Sherman et al., 2006).

Thermal regulation is a key component of infant stabilization and a key component of the “golden hour” practice guidelines. Temperature instability is a potentially preventable event. In the delivery room, a dedicated team member to manage the infant's thermal transition to extrauterine environment is essential to the “golden hour” practice and the overall well-being of the infant.

Teamwork

In 2004, the Joint Commission investigated cases of infant death or injury during delivery and found that ineffective communication and teamwork were the most common root causes that preempted the NRP steering committee to evaluate their educational process (Zaichkin & Weiner, 2011). Alton, Mericle, and Brandon (2006) agreed that critically ill infants are among the most medically fragile patients, and the tolerance for error within this population is extremely small. Delivery room resuscitation under the NRP program is a series of steps, involves continuous evaluation of the infant to interventions provided during delivery room resuscitation, and incorporates a team-based approach to performing the steps (AHA/AAP, 2006; Jukkala & Henly, 2009; Zaichkin & Weiner, 2011). Although teamwork is the recommendation, appropriate teamwork and interventions have been shown to be lacking in delivery room resuscitation (Finer & Rich, 2010). Neonatal resuscitation, particularly the resuscitation of the

VLBW infant requires careful surveillance, timely identification of complications, and timely and appropriate interventions. Individual provider performance can influence the neonatal delivery room process (Halamek et al., 2000).

In a study by Thomas et al. (2006), 132 teams were videotaped during neonatal resuscitation. The mean NRP noncompliance rate ranged from 15.9% to 54.5%. They also identified three factors that explained the variation in the team behaviors: communication, management and leadership. Rich, Leone and Finer (2010) also performed videotaping during delivery room resuscitation and found variations in compliance with NRP guidelines and team collaboration. Improving team performance and providing consistent care giving practices have been identified as fundamental principles to improve neonatal outcomes through the reduction of errors and improvement in patient safety (McGrath, 2009; Miller, Riley, Davis, & Hansen, 2008; Morey et al., 2002; Zaichkin & Weiner, 2011)

The Role of the NNP as Leader

The practice of nursing has always incorporated the development of a care plan with established goals: implementing, evaluating, teaching health care practices, delegating, directing, maintaining client safety, teaching theory, and collaborating with others (Bowen, 2008). The scope and responsibilities of NNPs include implementing care to high-risk infants, establishing medical diagnoses, ordering and evaluating diagnostic studies, using clinical assessment, and using decision-making skills to perform and monitor therapeutic procedures, which include delivery room management skills. NNPs attend high-risk deliveries, resuscitate babies, perform procedures, and problem solve situations in the delivery room (Bunger, 2006). Another major component of the NNP role is providing education to multidisciplinary teams. Eighteen of the twenty NNPs employed at this Midwest level III institution are NRP instructors. The NNPs offer

a valuable service to the infants for whom they provide care. The NNPs provide safe, cost-effective care with no documentation of untoward outcomes (Aubrey & Yoxall, 2001; Witt, 2009). The AAP recognized the ability of nurse practitioners to provide care similar to that delivered by a physician and often with a higher degree of patient satisfaction (2003).

Furthermore, the AAP recognized that optimal pediatric or neonatal care depends on a team-based approach. It is during collaborative practice that team-building relationships develop (Manser, 2009; McGrath, 2009; Ohlinger, Brown, Laudert, Swanson, & Fofah, 2003; Simmons & Sherwood, 2010; Simpson, 2005; Thomas et al., 2006).

NNPs work collaboratively with multiple disciplines in their daily patient care management. It has been well established that interdisciplinary teamwork improves the quality of patient care and safety outcomes (Gum, Greenhill, & Dix, 2010; Lerner, Magrane, & Friedman, 2009; Miller et al., 2008; Morey et al., 2002). Neonatal resuscitation principles incorporate teamwork in the stabilization process. The NNP is the principle leader of neonatal resuscitation in the delivery room within the hospital of interest. It is imperative that the NNPs understand the “golden hour” principles so that they may guide the delivery room management. This quality improvement project will focus on improving neonatal nurse practitioners’ delivery room management compliance with the “golden hour” concepts of delivery room care for infants born less than 33 weeks gestation. Implementation of a team approach, where each member has a primary focus to facilitate the transition of the infant, will enable the NNP to oversee all components of the infant’s transition and provide appropriate medical management interventions.

Implementation

Meetings with key stakeholders in this project were essential to its success. The key stakeholders were identified as the directors of the NICU and labor and delivery areas, the neonatology physician group, the NNP group, the NICU staff, the clinical educator, the infants, and their families. The directors, neonatologists, and NNP group are aware of the hospital's VON data and were supportive of the practice change that will help ameliorate the poor ranking. The research of potential causes of CLD and evidence-based practices to reduce the incidence of CLD was evaluated and dissemination occurred at a journal club meeting attended by neonatologists and NNPs. At the journal club meeting "golden hour" practices were discussed as a viable method to help reduce the incidence of chronic lung disease in VLBW infants. Exact guidelines of "golden hour" practices were developed. Three neonatologists and one other NNP agreed to review the planned recommendations for practice change and facilitate their groups' participation and performance. During the development process, other key stakeholders were identified including the respiratory therapy (RT) department, labor and delivery staff and newborn nursery staff. It was identified early that although the respiratory therapy department's director was supportive of respiratory therapists attending the deliveries of VLBW infants, the lack of staffing, productivity concerns, and experience concerns led to the development of a back-up plan for delivery room coverage by the RT. Collaboration and discussion continued among the neonatologists and the two NNPs until final guidelines for the "golden hour" practice were established. The "golden hour" practice guidelines were used for infants born before the completion of 33 weeks gestation. These new "golden hour" practice guidelines replaced the practices of minimal dialogue concerning role identification in the delivery room.

This journey involved communication with the institutional review board (IRB). It was found through this dialogue that IRB approval was unnecessary because no research was involved; this was a quality improvement practice change based on research literature.

The “golden hour” practice change for this unit included the addition of a third person in the delivery room to assist in the stabilization of the infant. Infants born before the completion of 33 weeks are delivered in the operating room. The “golden hour” practice incorporates pre-warming the operating room and the use of a chemical mattress in a preheated radiant warmer bed. The infant was to be placed, up to their neck, into a polyurethane bag that was placed on top of the chemical mattress on the warmer. Two hats were to be applied to the head (or a plastic wrap placed on the head with a hat covering). Also new with this practice was the application of a temperature probe. The focus on thermal support will reduce brown fat metabolism, maximize metabolic efficiency, reduce oxygen consumption and reduce caloric expenditure. The “golden hour” practice included the application of a pulse oximetry-monitoring probe. Oxygenation of the infant was to be an ongoing process; room air was the initial setting. Based on the pulse oximetry readings; oxygen was titrated to maintain pulse oximetry levels of 80-90 mmHg in the delivery room. Titration of oxygen was not to begin until two to three minutes after application of the pulse oximetry monitor to ensure accuracy of pulse oximetry readings and to enable the infant time to transition. Oxygen targeting prevents adverse outcomes of oxygen toxicity that include release of free radicals and proinflammatory markers that increase the propensity toward CLD and ROP. All delivery room respiratory support was to be provided through a T-piece resuscitation device. Other respiratory support changes included the application of an inspiratory hold for a five-second count then the conversion to mask CPAP to sustain PEEP. Additionally, infants born between 25 weeks gestation and 33 weeks gestation were to have a trial of CPAP

before intubation. If the infant was born less than 25 weeks gestation, the infant was to be intubated and given surfactant in the delivery room, preferably within the first 15 minutes of life. The intubated infant was transported to the NICU where he or she was re-evaluated to see if extubation to CPAP was possible. The goal was early extubation of an infant to a nasal ventilation mode as soon as possible, preferably within the first hour of life.

These practice changes focused on teamwork and a collaborative approach. Team focus and collaboration are the new recommendations from the 2010 NRP steering committee and are highly suggested to reduce the potential for errors (Brown, Ohlinger, Rusk, Delmore, & Ittmann, 2003; Jukkala & Henly, 2009; Rich et al., 2010). The NNP was to guide communication and stabilization practices through this team approach and each team member's role was to be clearly identified. The role of the NNP was to provide individualized delivery room respiratory management based on clinical assessment, knowledge, skills, and the available technology. Specifically, the NNP was to predetermine the initial respiratory settings and communicate that with the NICU nurse (RN) or RT who was to manage the T-piece resuscitation device. It was the responsibility of team members to collaborate regarding their assessment of the infant, to evaluate their component of the process, and to communicate with the rest of the team. The NNP was responsible for overseeing the stabilization process, but every team member was to be aware of the infant's respiratory status, oxygen saturation level, and thermal stability to enhance the infant's stabilization process and to communicate any concerns or suggestions to the team leader/NNP.

The CETEP model guided the appraisal of the critical components (e.g. key stakeholders, the impact on interdisciplinary and multidisciplinary departments, the cost-benefit analysis, and the alignment with the organizational philosophy). There was concern regarding safety issues

with this change of practice, in particular, the use of an inspiratory hold for all infants. All NICU RN staff and RTs are experienced with the T-piece resuscitation device; however, the application and duration of inspiratory hold was reviewed to minimize potential adverse outcomes such as pulmonary air leak. Other than the potential for pulmonary air leak, implementation of “golden hour” practices was viewed a method to enhance patient safety. Errors should be minimized by having all the team members fully aware of their individual roles and responsibilities.

Furthermore, the NNP would be interacting, overseeing, and encouraging dialogue during the “golden hour”. Every team member sees the process from a different perspective, and the information provided should help to either identify errors quickly or avoid errors completely.

Part of the CETEP model was to determine the method of communication and education. Collins et al. (2007) stated, “The best practice ever conceived will fail if the staff is not adequately educated *before* the change occurs” (p.6). Interdisciplinary personnel within this NICU included six neonatologists, 23 masters-prepared NNPs, and over 50 NICU based RNs with varying education levels and years of NICU experience. In addition to the NICU members, consideration of involvement with other departments was necessary. Respiratory therapists (RT) have a role in the “golden hour” practices. RTs are not unit based; they also have a mix of skill, education, and NICU experience. Another department that was included in this project was the maternal/child department. This department employs over 80 nurses that care for the mother/infant dyad in labor and delivery, postpartum, and newborn nursery areas. The “golden hour” stabilization practices begin in the delivery room. It was important that the labor and delivery staff be aware of the changes so they could help educate and support the families while the stabilization practices were occurring. Furthermore, the labor and delivery staff would be enlisted to help in room preparation. In times of high census, postpartum and newborn nursery

staff supplement NICU staffing. Although they would not be called to attend the deliveries, it was important that the nurses from these areas be familiar with the practice changes.

The process of education started with the neonatologists. The education of other members of the neonatology group was given by the three neonatologists that were a part of the developing process (see Appendix B). The primary NNP team member clarified the practice changes during one of the neonatology meetings. Education of the NNP group occurred at a planned staff meeting during the second week of February, 2011, with the planned implementation date of March 15, 2011. Education of the NNP group included providing an outline of the “golden hour” practice change guidelines with literature support and a poster board presentation of the “golden hour” practice. Handouts of the “golden hour” practice and a delivery room flow chart were provided to each NNP along with a documentation sheet (See Appendices B, C, & D). There was extensive dialogue between the NNP group members and the two NNP members involved in the literature review and development process. For the NNPs who were unable to attend the meeting, handout material was attached to the minutes of the meeting and distributed via email. The poster board presentation was also available in the unit for review. The two NNPs were available for questions, clarifications, and support.

Presentation of the VON data and the “golden hour” practice change was given to the NICU lead (charge) nurses at their February meeting. This was completed so that these key members had additional time to understand the practice changes and help trouble shoot potential problems in implementation before they occurred. The rest of the NICU staff members were introduced to the key concepts of “golden hour” practice during shift change report over a two-week period in March. This information was presented by the two NNP team members. The poster presentation of the “golden hour” practice was left in the unit conference room for easy

access and referral. In addition, the delivery room flow chart was placed into each nursing chart alcove for the staff to review periodically. The NNP team members and the clinical nurse educator developed a self-study packet. This packet contained research articles that provided foundation for the practice change, specifically targeting thermal regulation and oxygen toxicity. The NICU staff was expected to have completed the self-study packet by the end of March. Upon completion of the self-study packet, we celebrated by “inducting” the staff member into the ‘SAT SQUAD’ team. Members received a button to be displayed on their uniform.

Education about the RTs’ role in delivery room management occurred at their monthly meeting the first week of March. RTs do not routinely attend the high-risk deliveries, so in addition to delivery room “golden hour” care practices, the RTs were given information regarding operating room attire, the location of the clothing, and the location of respiratory supplies in the operating room.

General information of the “golden hour” practice changes were disseminated to the labor and delivery staff and newborn nursery staff through a mass email. The email highlighted the major components of the “golden hour” practices with brief rationale. The staff was encouraged to contact the two NNPs on the development team if they desired additional information.

Evaluation

This quality improvement project is a convenience sampling of all infants born prior to the completion of 32 weeks gestation in this Midwest hospital. Infants born outside of this hospital but transferred into the level III NICU were excluded. This Midwest hospital does not include cardiac services and is limited in the surgical services it provides, therefore, any infant born in this facility but transferred would have the delivery room “golden hour” practice data included but would be eliminated from the long-term data collection analysis. Descriptive and

qualitative data were obtained from a documentation sheet that was developed to assist in the evaluation of compliance with the “golden hour” practices (see Appendix D). It was the responsibility of the NICU team attending the delivery to complete the delivery room documentation form. Completed forms were placed into a file locked in the NNP office. Every attempt was made to ensure the form was entirely completed. Non-identifiable aggregate data was recorded in a Microsoft Excel spreadsheet by the principle investigator. Qualitative data was coded as either positive or negative. Missing data was excluded from compliance calculations. Evaluation criteria of the NICU team compliance was based on specific respiratory components, oxygen components, thermal regulation components, and teamwork components, which are outlined in Table 2. Evaluation of NICU team overall compliance with the “golden hour” practice was the average percentage of the specific “golden hour” components. As with any practice change, it is expected that there would be barriers to the implementation of the “golden hour” practice and that changes might need to be made to the current plan, therefore evaluation of the NICU team compliance was to be completed at three months, six months, and twelve months after the introduction of the “golden hour” practice.

Compliance Rates Expected

It is desired to have an overall compliance rate of 85% by the end of three months, a 90% compliance rate by the end of six months and a 100% compliance rate by 12 months.

Respiratory compliance with the “golden hour” practice is a key component to decreasing the long-term complications. Changes in practice included the initiation of a five-second inspiratory hold of 20 cm H₂O pressure immediately upon placement into the radiant warmer, the use of a T-piece resuscitation device for respiratory management, and the initiation of mask CPAP immediately after the inspiratory hold with the sustainment of PEEP. Additional changes

included the use of room air for initial resuscitation, and application of pulse oximetry monitor followed by oxygen targeting. Specific surfactant administration criteria were implemented for those infants requiring intubation.

Thermal regulation has been an ongoing struggle in this Midwest level III NICU despite attempts to improve. It was desired to increase compliance with use of the polyurethane bag and chemical warming mattress. A new challenge was the placement of two hats on the infant or a plastic barrier and one hat. It was desired to have the application of the hats occur within the first minute of life. It was desired to have the infant be eutermic in the delivery room prior to transfer to the NICU. However, this can be influenced by factors that are out of the NICU team's control. Relocation of the NICU has lengthened the distance that the NICU team must travel to admit an infant into the NICU. The VON data showed the admission temperature for infants at this gestational age was normal or eutermic only 34% of the time prior to this move. The "golden hour" practices increases consistency in thermal management, therefore, we desired an increase of infants within the eutermic range upon admission to the NICU. Maintenance of a eutermic environment is important for optimal organ system functioning. Therefore, compliance for removal of the polyurethane bag and thermal maintenance one hour after polyurethane bag has been removed is important in the overall welfare of the infant.

Teamwork is important to the overall "golden hour" practice change. The evaluation of the teamwork component was extrapolated from the questions posed on the delivery room documentation form.

The original intent of this project was to investigate ways to decrease the incidence of CLD thereby reducing our VON scores. The VON reports are produced in the fall of the following year of data submission. The reason for the delay in reporting is due to the long length

of hospitalizations for some infants. Therefore, it could be up to two years before the true report of this “golden hour” practice change is seen in the VON report, hence this project will not include the long-term data reported by VON. The long-term goal is to have a 10% decrease in the incidence of CLD in our VON data the first year after implementation with an additional 5-10% decrease the second year. These reduction rates would place this Midwest level III NICU in the acceptable level for benchmarking of CLD among similar hospitals within the VON system.

Potential Barriers to Implementation

An expected barrier to this practice change is the use of oxygen in the delivery room. In the past oxygen has been used liberally in the delivery room setting. It has only been in the past year that the concept of reducing oxygen to 40% for delivery room resuscitation practices had been discussed. The NRP guidelines still recommend the use of oxygen in the delivery room and give a range of 30-100%, although these guidelines do indicate that room air is an appropriate starting point. Requiring the NNPs to start resuscitation in room air (21% oxygen) could be difficult to accomplish.

The conversion to the T-piece resuscitation device for initiating respiratory support has also been voiced as a concern by the NNPs. Many expressed concerns that they are able to “feel” compliance with the other types of bag mask devices that is lacking with the T-piece resuscitation device. During this dialogue another barrier that was identified is that the NNPs are used to performing all of the respiratory support cares (e.g., providing the PPV, CPAP, and oxygen administration), and it might be difficult for them to relinquish the initial care of the infant to the RT or second nurse team member.

There was much dialogue and concern expressed by the NNPs and neonatologists regarding the use of an inspiratory hold. The concept of opening the basilar lung fields is understood, but there is an expressed concern that this respiratory strategy would increase the incidence of pneumothoraces and potentially increase volutrauma. Additionally, the timing of the inspiratory hold application potentially posed a barrier to the compliance of the “golden hour” practices. This “golden hour” practice calls for the inspiratory hold to be initiated immediately upon the infant’s placement into the radiant warmer. There was opinions by some of the physicians/stakeholders that the inspiratory hold should be delayed until the infant shows signs of respiratory distress (nasal flaring, grunting, retractions, or oxygen requirement) before its application.

Another barrier was the completion of the documentation form. It is desired that the form be completed in real time, however, in the delivery room the documenting RN might be called to perform other resuscitative tasks and not be able to complete the form until later and/or may choose not to document information leading to missing data.

Outcomes

It has been six months since the implementation of the “golden hour” practice change. There have been 49 infants born < 33 weeks gestation, admitted to the NICU, between March 12, 2011 and September 2011. Thirty-three of these infants were born in the first three months, 17 in months 4-6. One infant was born at a different location and transferred into this Midwest hospital and thus was eliminated from the “golden hour” compliance data collection. Neonatologist attended nine of the 48 deliveries; NNPs attended all 48 deliveries. Attendance by RT increased from 37.5% in first three months to 73% in last three months. There were six deliveries in which a second RN or RT were not available. The average gestational age for the

first three months was 29 6/7 weeks. For months four through six, the average gestational age was 28 3/7 weeks. This gave an overall gestational average of 29 3/7 weeks. Seventeen of the 48 infants were born at less than 29 weeks gestation (35%). Table 3 identifies compliance with “golden hour” practice

Respiratory Data

Delivery room equipment for respiratory management (T-piece device and Laryngoscope) was checked and available prior to delivery in first three months 76.5% of the time. Compliance improved in months 4-6 to 100%. In months one through three, 84% of the infants received an inspiratory hold for 5 seconds (N=25). Compliance increased to 100% of the infants receiving an inspiratory hold (N=16). An inspiratory hold of 20 cm pressure – the recommended setting- was given 33% (N=16). There was a propensity to provide an inspiratory hold of 18 or 19 cm pressure (49%, N=19).

CPAP was provided to 96% (N=46) of the infants within the first moments of life. Compliance with application of CPAP immediately after the inspiratory hold improved in months four through six (see Table 3). Four infants had the cm of H2O pressure increased during delivery room management. A reason for non-compliance with immediate CPAP application was to observe the infant’s need for respiratory support.

PPV was provided to 59% of the infants (N=26). The T-piece resuscitation device was used for PPV in all but three delivery resuscitations (one in months one through three and two in months four through six) in which the self-inflating bag was used. Initial inspiratory pressure provided during the PPV equaled the inspiratory hold, adjustment upward of the inspiratory pressure occurred in nine of the delivery room resuscitations.

Intubation occurred in 51% of the infants (N=27) delivered with surfactant administration occurring in 70% (N=19). Surfactant administration occurred within the first 15 minutes of life in 68% of the infants (N=13), but 100% within the first hour of life.

Oxygen

There was a 100% compliance with initiating delivery room respiratory interventions with room air. In the first three months 59% of the infants (N=19) received supplemental oxygen with initiation ranging between one and nine minutes of age. In the last three months, 87.5% of the infants (N=14) were given oxygen supplementation. There was a lengthening in the time of oxygen initiation with a range of 2 ½ - 9 ½ minutes of age. More details regarding oxygen delivery are provided in Figures 1, and 2. Titration of oxygen by 2-3% to maintain saturations of 80-90% in the delivery room occurred 12.5% in the first three months, with slight improvement to 14% in last three months. Figure 3 shows that there was an effort to reduce the oxygen exposure in months four through six by the reduction in the number of infants initially started at 30% or greater oxygen concentration. No infant since initiation of the “golden hour” practice has sustained a pneumothorax.

Thermal Regulation

Thermal regulation compliance components are outlined in Table 3. Compliance with polyurethane bag usage improved over time. Compliance with placement into the polyurethane bag and onto a chemical mattress decreased in the four to six month segment due to lack of staff readiness secondary to precipitous deliveries. Compliance with the application of two hats or a plastic barrier and one hat improved in the second segment. VON recommends a core temperature of 98.0 to 99.0 °F throughout the process; Table 3 outlines our unit’s compliance with thermal regulation within this range. All temperatures in this unit are taken axillary; this

Midwest NICU has an acceptable temperature range of 97.2 to 99.0 °F. Table 4 provides data regarding the thermal regulation components. Summation of thermal regulation shows an increase in compliance in months four through six with all components except in the category of thermal stability one hour after the polyurethane bag has been removed.

Long term Data

In first three months, 33 infants were admitted – one was eliminated due to being born outside this institution, three other infants were transferred, therefore 29 infants were included in the long-term data. There were nine infants classified as having CLD @ 28 days of life (38%), there was one infant classified as having CLD @ 36 weeks CGA (3.4%). For months four through six, 17 infants were born that met “golden hour” criteria, two infants were eliminated from the long-term data (one transferred, one expired). Three infants have yet to reach the 28 day of life mark with an additional two that have yet to reach the 36-week CGA mark. As of this time, 40 of the 44 infants are older than one month, 12 have been classified as having CLD at 28 days of life (30%). Thirty-eight infants are older than 36 weeks CGA, two have the diagnosis of CLD (5.2%). No infant has been diagnosed or required treatment for ROP. Only one of the 40 infants had an IVH (2.5%) and it was a small grade I on the left.

Qualitative data

Qualitative data showed a positive response for the “golden hour” practice (96%, N=25) from the NICU nurses. Key concepts that lead to the positive results were improved communication and teamwork. Qualitative data from the RT showed they are feeling more comfortable in the delivery room and would like to have a more active role. RT comments showed that there are times when the NNP assumes the RT role by taking over the ventilation of the infants, particularly the extremely premature infants.

Discussion

There still seems to be a lack of compliance to titrate oxygen in 2-3% increments. Potential reasons for the lack of compliance with titration of oxygen could be due to the blender design, which gives oxygen markings that start at 21% then increases to 30% and sequentially in 10% increments. Our QI data is in alignment with the research that premature infants have an oxygen requirement and that judicious use of oxygen in the delivery room can be guided by the pulse oximetry trend that limits exposure and expedites adjustment of oxygen to the level that meets the infant needs. The majority of our infants were weaned to room air by the time they were transported to the NICU.

Application of an inspiratory hold was controversial within the developing team. The developing team chose to implement, but at the lower end of the spectrum described in the research literature. Review of delivery room cases by members of the developing team have postulated that intubations and oxygen delivery might have been negated if we had optimize airway management by lengthening the duration of the inspiratory hold or provided reapplication of the inspiratory hold titrated to a higher pressure.

Use of the T-piece resuscitation device has helped target the desired inspiratory hold and PEEP provided to our infants. The majority of delivery room resuscitation cares were provided used this device however, there were a few instances in which the infant remained bradycardic after the initial inspiratory hold and initiation of mask CPAP, the team switched to the self-inflating bag to provide positive pressure ventilation. Debriefing with these team members centered on the lack of “feeling” the lung compliance. The transition from self-inflating bag to the T-piece resuscitation device might have been better accepted had mock codes or simulations been employed prior to the initiation of the QI project. Simulations would have facilitated

expectations of team members and enhanced communicate particularly about respiratory strategies.

During dissemination of the “golden hour” data at the October NNP meeting, it was called into questioned whether the implementation of “golden hour” practice was accountable for the reduction in this unit’s incidence of CLD. In May 2010, our unit changed the brand of surfactant administered. Review of the raw data regarding the surfactant change confirms that the “golden hour” practice has not been skewed by the switch in surfactant brands.

Although our data show improvement in thermal stability for the VLBWs, thermal regulation continues to be an ongoing struggle for this NICU. Discussion on strategies that can help stabilize temperatures is in progress.

Conclusion

Since the implementation of the “golden hour” practice, this NICU has seen a significant reduction in the incidence of CLD in infants born less than 33 weeks gestation. As with any QI project guided by the CETEP model, continual evaluation of the practice is important. The developing team is in the process of educating staff on increasing the duration of the inspiratory hold to ten seconds. We continue to suggest an inspiratory hold of 20 cm of H₂O pressure with the advisement to increase the pressure incrementally up to 25 cm if the desired lung expansion is not achieved or the infant remains bradycardic. The goal is to optimize airway and breathing before implementing oxygen. Discussion is also in progress as to methods of improving thermal stability.

Change is hard, but this NICU has embraced this practice change. Through this practice change communication and teamwork has been enhanced which leads to a positive experience for all involved and the provision of excellent care.

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Table 1

The Vermont Oxford Network data for infants born less than or equal to 33 weeks gestation at this Midwest Level III NICU

	2008	2009
CPAP before intubation	34%	27.5%
Delivery room oxygen administration	94.6%	93.1%
Delivery room surfactant administration	32.1%	41.4%
Delivery room endotracheal ventilation	53.6%	64%
Admission temperature within eutermic range	10.9%	39.7%
Incidence of chronic lung disease	52.5%	31.9%

Table 2

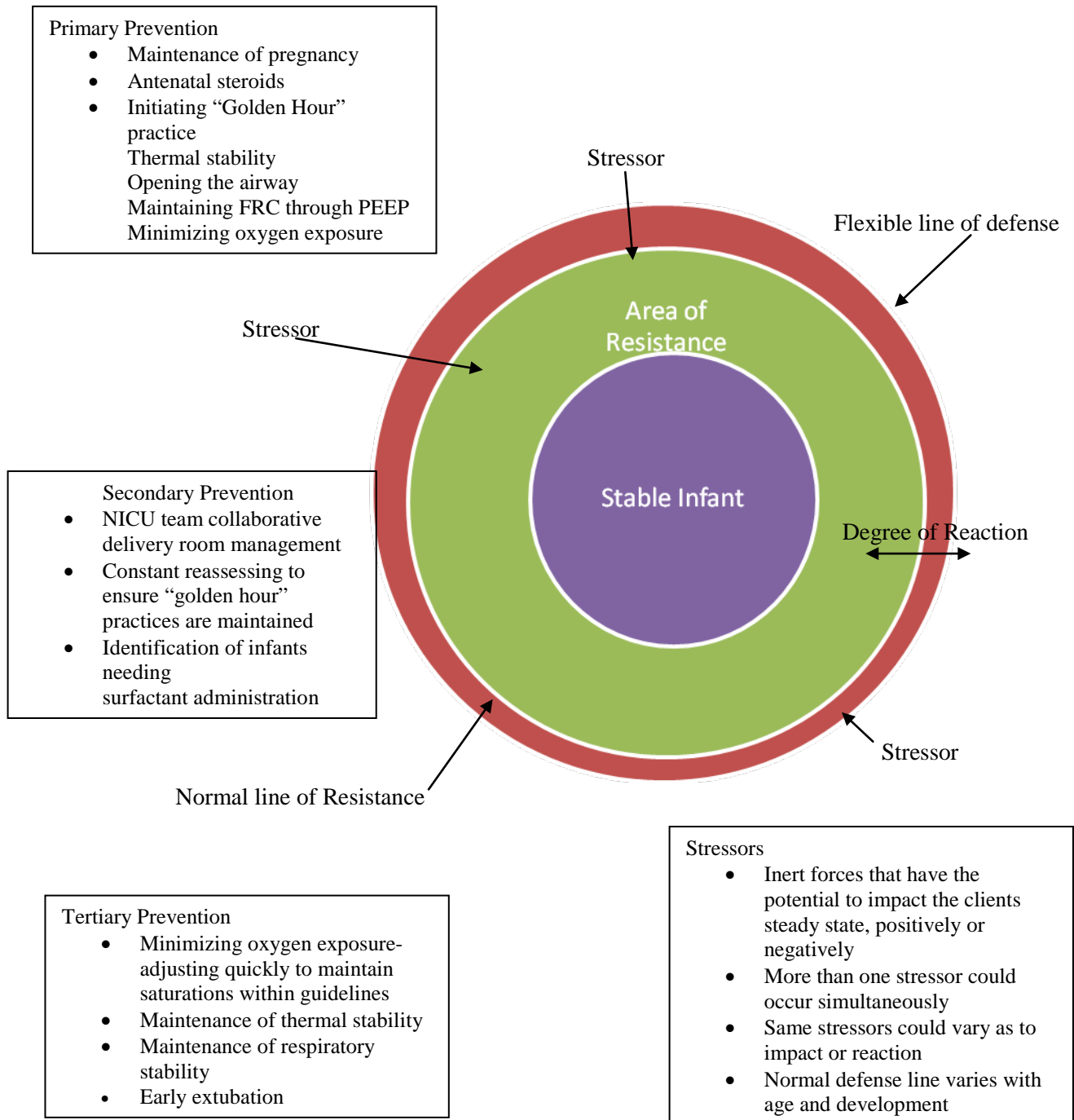
Desired compliance percentages for individual “golden hour” practice outcomes

	Desired Percentage
Respiratory:	
Inspiratory hold given	90%
CPAP applied immediately after inspiratory hold	95%
CPAP applied before PPV or intubation	95%
Use of T-piece resuscitation device for ventilation support	95%
Infants born < 25 0/7 weeks intubated prior to 15 minutes	95%
Curosurf given within first 15 minutes for infant born < 25 0/7weeks gestation	95%
Curosurf if given – administered within the 1 st hour of life	95%
Oxygen:	
Oxygen started at room air	100%
Oxygen titrated in 2-3% increments	90%
Thermal Management:	
Polyurethane bag used	95%
Placed in polyurethane bag within first minute of life	95%
Placed on chemical mattress	95%
Two hats applied or 1 hat/plastic barrier	95%
Application of two hats or 1 hat/plastic barrier within first minute of life	90%
Infant delivery room temperature between 98.0-99.0°F	75%

Infant NICU admission temperature between 98.0-99.0°F	60%
Infant temperature between 98.0-99.0°F when polyurethane bag removed	90%
Temp between 98.0-99.0°F one hour after polyurethane bag removed	90%
<hr/>	
Overall compliance percentage	85%

Appendix A

NSM Schematic for the Preterm Infant



Appendix B

Education for “Golden Hour” Practice

RT/RN:

NeoPuff set up and ready – 20 cm (PIP), 5cm PEEP, room air

Appropriate size mask

Primary focus is application of mask CPAP with T-piece resuscitation device immediately upon placement in warmer

Give 5 second inspiratory hold of 20 cm PIP then go to straight PEEP of 5 cm –
Assist with intubation and transferring modes of ventilation from mask to ETT
Adjusting PEEP first the increasing PIP

RN:

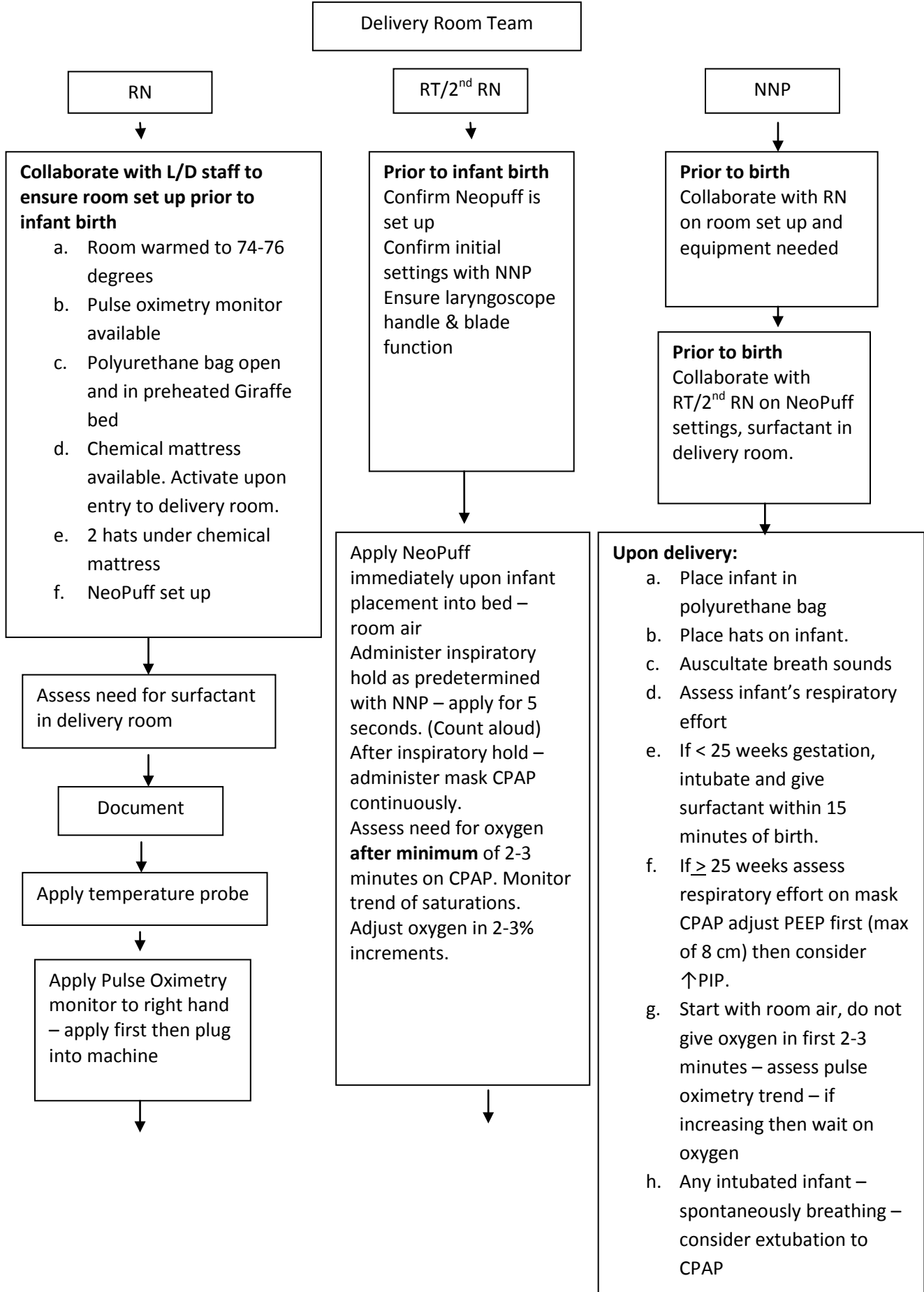
1. Thermoregulation
 - a. Equipment/warmer pre-warmed as well as making sure room temperature is 76 degrees
 - b. Plastic bag open
 - c. Chemical mattress ready – popped – 2 hats under chemical mattress
 - d. Place temp probe on infant upon entry to bed.
 - e. Monitor temperature frequently
2. Oxygen targeting
 - a. In delivery room, place pulse oximetry monitor on right hand
 - b. Start on room air – for at least first 2-3 minutes – monitor **trend** of saturation readings.
 - c. If saturations not trending upward into 80’s then start oxygen – increase by 2-3% at a time. Target saturations in delivery room is 80-90%.
 - d. Target saturation readings of 88-92% upon admission to the NICU. – try hard not to overshoot – prevent hyperoxia
 - e. Set monitors for 85-95% – if infant has frequent desaturations –try to see if infant self resolves. If infant does not self-resolve, then try tactile stim and other interventions before increasing oxygen (talk with NNP to consider adjusting respiratory support).
3. Respiratory management
 - a. CPAP – mask or nasal
 - b. Use chin strap if necessary to maintain PEEP
 - c. Nasal ventilation – before intubating
 - d. Suctioning – q 3 hrs back of throat with catheter.
 - e. Keep on CPAP as much as possible – few breaks in flow.

Neo/NNP:

1. Communication
 - a. Dialogue with each person going to delivery
 - b. Stress collaboration/communication
 - c. Identify individual roles
 - d. Assess room warm, equipment ready
 - e. Determine cm PIP for inspiratory hold and PEEP for afterwards – communicate with RT/RN
2. Delivery room Cares:
 - a. Place infant into polyurethane bag immediately – secure up to arms
 - b. Place 2 hats on infant or plastic covering and one hat
 - c. Ensure that mask CPAP applied – inspiratory hold given then revert back to CPAP.
 - d. Start at room air – wait for minimum of 2-3 minutes for pulse oximetry readings to calibrate. Adjust oxygen ONLY if saturations are not trending upward. Target saturation range in delivery room of 80-90%. Upon admission to the NICU target 88-92%.
 - e. Give inspiratory rise time of 18-22 cm PIP
 - f. Start at 5 cm PEEP
 - g. Adjust PEEP first if aeration is poor – may increase to max of 8 cm PEEP
 - h. Adjust PIP
 - i. For infants 24 6/7 weeks gestation – intubate and give surfactant within 15 minutes of birth. Consider extubation back to mask CPAP if having spontaneous respiratory effort.
 - j. If oxygen requirement increasing – consider adjusting respiratory support (i.e. increase PEEP or give IMV)
 - k. Infants 25 weeks gestation or greater - assess respiratory effort as long as spontaneously breathing maintain on mask ventilation in delivery room.
 - i. Make decision within first hour if surfactant replacement therapy required. Base decision on oxygen requirement of >40% or trending upward, CXR and clinical status.
 - l. If intubated consider extubation to nasal ventilation upon admission/stabilization to the NICU – preferably within first hour.
3. Intubation Criteria:
 - a. No spontaneous breathing
 - b. Increased retractions
 - c. Increased oxygen requirement > 40%
 - d. pH < 7.25 (7.20), pCO₂ > 65
 - e. Significant apneic events

- f. Maxed SiPAP/CPAP /nasal ventilation – Hudson prongs with nasal ventilation modes – work in ac/pc mode- give same vent settings you would if you had intubated.
 - g. Once intubated – decide surfactant or not – extubated to CPAP asap if intubated for surfactant administration.
4. Ventilator strategies:
- a. If infant is spontaneously breathing – consider extubation
 - b. PEEP is friend – increase PEEP first – improved oxygenation, improve lung expansion, maintain lung volumes, increase FRC, improve ventilation-perfusion matching, decrease pulmonary vascular resistance, decrease atelectasis, lower upper airway resistances
 - c. Minute ventilation volumes of 0.3 or greater with tidal volumes of at least 4 ml/kg – try intubated CPAP x 5 minutes – if able to maintain same volumes then extubated.
 - d. If MAP is > 10 and have not met minute ventilation of 0.3 or tidal volumes – consider change to HFOV.
 - e. Frequent desaturations –
 - i. Encourage tactile stimulation before increasing oxygen
 - ii. lower saturation limits - do not raise them – we need to prevent hyperoxia
 - iii. Oxygen titration in only 2-3% increments. RN will notify NNP if oxygen is up by > 5% increments and unable to wean down.

Appendix C: Delivery Room Flowchart



Once infant stabilized. Transport to NICU.
 Once in the NICU – if intubated and infant is spontaneously breathing – clinically stable, consider extubation to nasal ventilation within first hour of life.

Documentation Form
 RN _____

Gestational age: _____ Time of Birth: _____

Placed into polyurethane bag yes/ no on chemical mattress yes / no @ _____ a.m./p.m

Two hats applied or plastic barrier & one hat applied at _____ a.m./p.m

NeoPuff set up prior to delivery yes / no

Laryngoscope/blade checked prior to delivery yes/ no

Inspiratory hold of _____ cm PIP x 5 seconds given

Started on mask CPAP @ _____ a.m./p.m. with _____ cms H2O

Adjusted to _____ cm @ _____ a.m./p.m.

PPV given yes / no what settings _____

Oxygen initiated @ _____ minutes of age with initial setting of _____%

for sats of _____ Adjusted to _____% at _____ a.m./p.m

Percentage of oxygen needed to maintain sats 88-92 _____

Intubated at _____ minutes of age with _____ ETT secured @ _____ cms

Surfactant given yes / no @ _____ minutes of age Dose: _____

Infant's axillary delivery room temperature: _____ - _____ °C taken at _____ a.m./p.m

Transferred to the NICU on (PIP/PEEP/O2/mask or ETT) _____

Extubated at _____ minutes of age to (resp support needed –ie CPAP, O2) _____

Admission NICU respiratory support settings: _____

Admission NICU axillary temperature _____ °C taken at _____ a.m./p.m

Giraffe bed closed to isolette @ _____ a.m./p.m

Polyurethane bag removed at _____ a.m./p.m. with axillary temp of _____ °C

Axillary Temp 1 hour after polyurethane bag removed _____ °C

PLEASE TURN PAGE OVER AND ANSWER THE FOLLOWING QUESTIONS:

What did team do well? _____

What can the team improve upon? _____

What follow-up if any is needed?

Figure 1

Average minutes for oxygen initiation in the delivery room

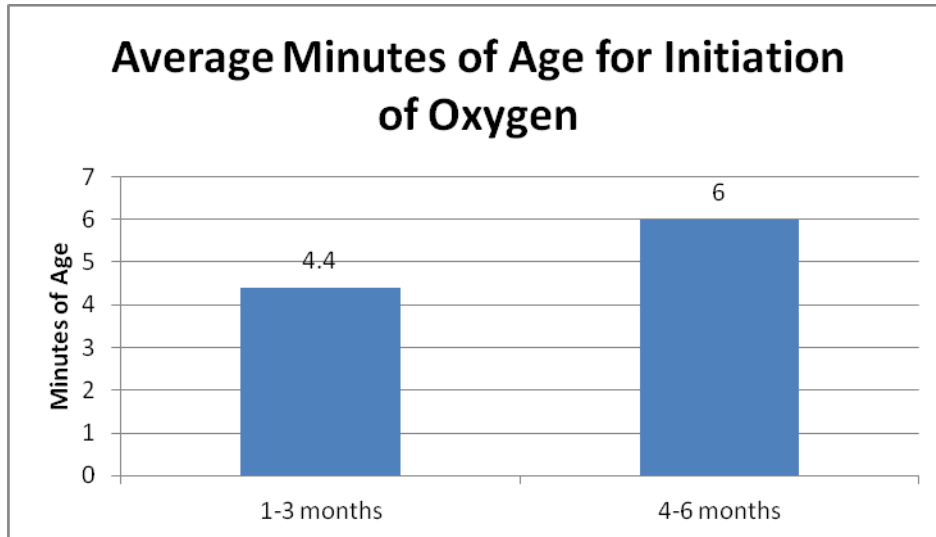


Figure 2

Breakdown of initial concentrations of oxygen delivery in the delivery room and ability to wean oxygen to room air by time of admission to the NICU.

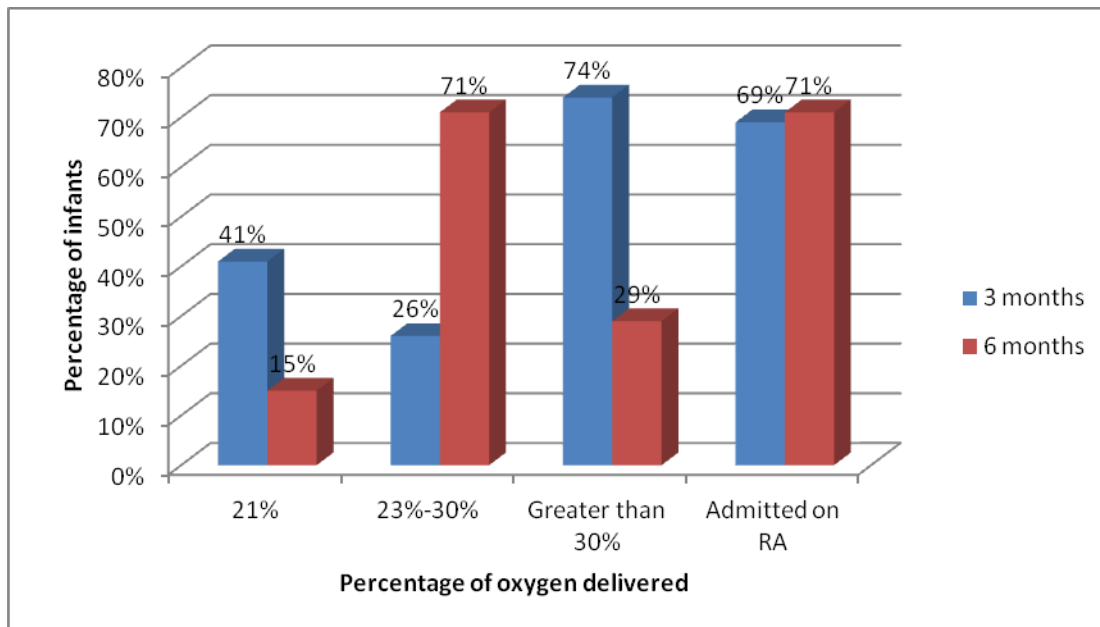


Figure 3

Number of infants receiving oxygen supplementation broken down in initial concentrations delivered.

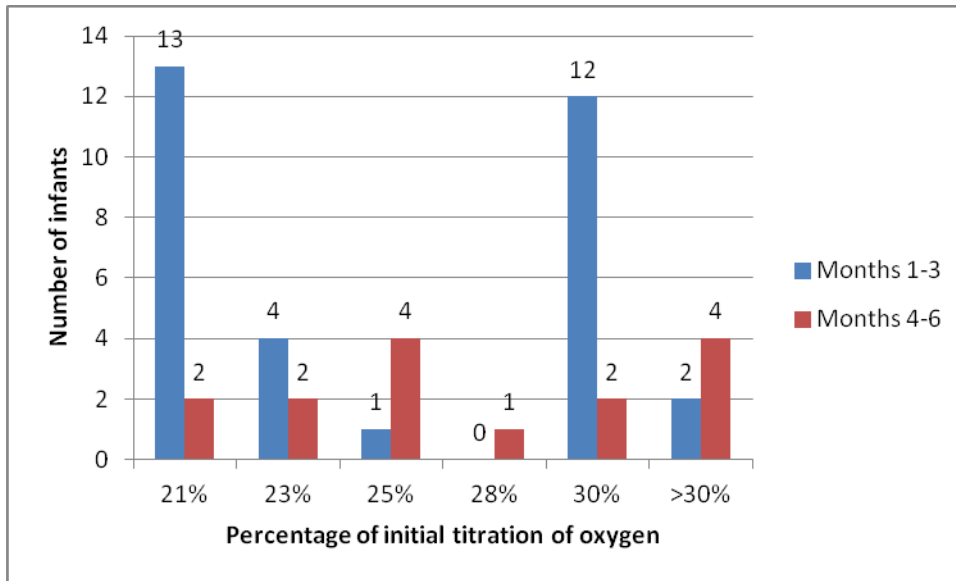


Table 3

Compliance percentages for individual “golden hour” practice outcomes

	Desired Percentage	One -Three month Percentages	Four -Six month Percentages
Respiratory:			
Inspiratory hold given	90%	84%	100%
CPAP applied immediately after inspiratory hold	95%	73%	81%
CPAP applied before PPV or intubation	95%	97%	100%
Use of T-piece resuscitation device for ventilation support	95%	97%	88%
Infants born < 25 0/7 weeks intubated prior to 15 minutes	95%	-	100%
Curosurf given within first 15 minutes for infant born < 25 0/7weeks gestation	95%	-	100%
Curosurf if given – administered within the 1 st hour of life	95%	100%	100%
Oxygen:			
Oxygen started at room air	100%	100%	100%
Application of pulse oximetry monitoring device	100%	100%	100%
Oxygen titrated in 2-3% increments	90%	12.5%	14%
Thermal Management:			
Polyurethane bag used	95%	97%	100%
Placed in polyurethane bag within first minute of life	95%	96%	93%
Placed on chemical mattress	95%	94%	93%

Two hats applied or 1 hat/plastic barrier	95%	96%	100%
Application of two hats or 1 hat/plastic barrier within first minute of life	90%	48%	80%
Infant delivery room temperature between 98.0-99.0°F	75%	35%	27%
Infant NICU admission temperature between 98.0-99.0°F	60%	45%	44%
Infant temperature between 98.0-99.0°F when polyurethane bag removed	90%	40%	60%
Temp between 98.0-99.0°F one hour after polyurethane bag removed	90%	38%	36%
Overall compliance percentage	85%	74%	80%

Table 4

Comparison data for this NICU “golden hour” thermal regulation practice

	One - Three Months	Four - Six Months	Total
Average Infant delivery room temperature	97.0	98.2	97.9
Average Infant admission temperature	98.2	98.1	98.2
Average infant temperature when polyurethane bag removed	98.2	98.1	98.1
Average infant temperature one hour after removed from polyurethane bag	98.0	97.8	97.9
Average Infant delivery room temperature with two hats			97.8
Average Infant Delivery room temperature with plastic barrier and hat			98.0
Average infant NICU admission temperature with two hats			98.1
Average infant NICU admission temperature with plastic barrier and one hat			98.1
Average time for NICU admission temperature to be taken from birth time			28 minutes
Average time for closure of giraffe bed from birth time			109 minutes
Average Infant temperature prior to removal of polyurethane bag			98.1
Average Infant temperature one hour after removal from polyurethane bag			97.9
Average time polyurethane bag removed from birth time			169 minutes
Infant’s temperature in delivery room of 97.2-99.0 axillary	58%	67%	
Infant’s admission temp between 97.2-99.0 axillary	68%	75%	

Infant's temperature between 97.2-99.0 at time of polyurethane bag removal	87%	93%
Infant's temperature between 97.2-99.0 one hour after polyurethane bag removed.	93%	86%
