MANAGEMENT OF HEATED HIGH-FLOW NASAL CANNULA WITH PRETERM AND TERM NEONATES

by

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A scholarly project submitted in partial fulfillment
of the requirements for the degree

of

Doctor of Nursing Practice

in

Family and Individual Health

MONTANA STATE UNIVERSITY
Bozeman, Montana

November 2018

DEDICATION

I would like to dedicate this project to all the nursery, NICU, PICU, and pediatric nurses. These jobs are not for the faint of heart; they are always changing. There is new literature everyday requiring you to always stay up to date on your knowledge, ask questions, and be a strong advocate for a population who can't be their own advocate. I would also like to send the most squeezable hugs to my family and special guy in my life. Their encouragement, patience, and strength helped me through this whole project.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my committee chair, Dr. Jennifer Sofie and my committee. This project has taught me diligence, the power of encouragement, and appreciation. In learning these characteristics, Dr. Sofie and the rest of the committee displayed all of these qualities to me and more. This project also gave me more respect for what goes into research, changing or creating protocols at a macro level, and evidence-based practice. Doing any of these tasks takes time, commitment, and fervent desire to make healthcare a better, safer place to be.

Secondly, to the rural, centrally located hospital special-care-nursery nurses and special-care-nursery educator, a huge thank-you and profuse gratitude for allowing me to be a part of their culture. Everyone was more than willing to help, wanted to know results of the survey, and was willing to come to the seminar I conducted. These nurses and educator welcomed a hard task of learning something new without questioning and were eager to make sure their practice was the best they could provide for their patients.

Also, a huge thank-you to Vapotherm for funding Seattle Children's Respiratory Therapy manager Robert DiBlasi to put on a one-hour seminar for the pediatricians, SCN nurses, and respiratory therapy in the rural, centrally located hospital. A huge thank-you to Robert DiBlasi for taking on this presentation and using his own time to teach the care givers in this rural, centrally located hospital the most up-to-date information on heated high-flow-nasal-cannula use in the neonatal environment.

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ABSTRACT

This project addressed the need for education on using heated high-flow nasal cannula (HHFNC) on term and preterm neonates at a rural, centrally located hospital. The education needs were found in a two-part process: assessing the current special-care-nursery (SCN) nurses' knowledge on management of HHFNC and reviewing the current protocol for clarification. The nurses' understanding was assessed by using a survey that was quantitatively analyzed, and which identified two areas needing improvements: assessing the neonate when on HHFNC and education on the consequences of poor management of HHFNC. Survey data was used for an educational service on HHFNC provided by the Seattle Children's Respiratory Therapy (RT) manager. This seminar was provided to the SCN nurses, pediatricians, and RT department at the rural, centrally located hospital. Along with the seminar, a presentation was given by the author that reviewed the results of the survey and how to find and use the current policy.

CHAPTER ONE

INTRODUCTION

There were 3,978,497 neonates born in the United States in the year 2015 (Centers for Disease Control, 2018). Out of 3,978,497 neonates born that year, 23,000 of them died within the first year of life, which is 5.9 deaths per 1,000 births (Centers for Disease Control, 2018). The five leading causes of death in the United States were: birth defects, preterm birth, sudden infant death syndrome, maternal pregnancy complications, and injuries (Centers for Disease Control, 2018). Montana recorded 75 of those deaths, which is six deaths out of every 1,000 births (Centers for Disease Control, 2018). Out of these complications, preterm births accounted for 8.4% and low birth rate accounted for 7.1% of the 75 deaths in 2015 (Centers for Disease Control, 2018).

There are many complications that preterm and low-birth-weight neonates can experience including breathing complications (McCance, Huether, Brashers, & Rote, 2014). Breathing complications are a vital risk during the transition into extra-uterine life and can occur in any neonate, but there is a higher incidence in those who are preterm and low-birth-weight (McCance et al., 2014).

Background and Significance

In the United States, 90% of neonates are born without complications, but the other 10% of neonates may require oxygen supplementation (Cox & Raghuveer, 2011). Oxygen supplementation can be provided in many forms, including blow-by oxygen,

hood, Continuous Positive Airway Pressure (CPAP), nasal cannula, or endotracheal intubation (Hacker, Gambone, & Hebel, 2016). The amount of respiratory distress will determine the type of oxygen modality to use and the amount of oxygen and pressure.

When neonates are born, there can be complications during the transition from intrauterine to the extra-uterine environment (Hacker et al., 2016). Breathing is one of the most vital of the physiological processes that needs to happen immediately for the neonate to switch from fetal circulation to extra-uterine circulation (Hacker et al., 2016). If the neonate cannot accomplish ventilating on their own, it is considered a medical emergency and requires immediate intervention (Hacker et al., 2016).

If neonates start showing signs of decompensation, such as increased work of breathing, retractions (subcostal, intercostal, supraclavicular), nasal flaring, asymmetrical breathing, tachypnea, tachycardia, and grunting they will need oxygen and airway pressure to facilitate lung expansion (McCance et al., 2014). Oxygen and airway pressure can be delivered by heated high-flow nasal cannula (HHFNC), CPAP machine, or endotracheal intubation and mechanical intervention (Hacker et al., 2016).When neonates demonstrate signs of improved oxygenation and ventilation determined by chest x-ray evaluation, blood gas monitoring, and physical evaluation, the supplied supportive airway can be weaned and ultimately discontinued (Hacker et al., 2016).

Definitions

- Heated High-Flow Nasal Cannula (HHFNC): Non-invasive ventilation therapy utilizing small, thin, tapered, binasal tubes that deliver oxygen or blended

oxygen/air at gas flows of more than 1 L/min (Wilkinson, Anderson, O'Donnell, De Paoli, & Manley, 2016).

- Continuous Positive Airway Pressure (CPAP): A machine that forces humidified air into the lungs with enough pressure to overcome obstructions in the airway and to stimulate normal breathing (McCance et al., 2014).
- Respiratory Distress Syndrome (RDS): A syndrome that is usually found in premature neonates, caused by a lack of surfactant, which decreases the alveolar surface area available for gas exchange (McCance et al., 2014).
- Blow-by Oxygen: Passive oxygen provided by an oxygen device to assist in increasing oxygen saturations (Hacker et al., 2016).
- Oxygen Hood: Usually a plastic device that can be placed over a neonate's head that delivers passive oxygen to assist in increasing oxygen saturations for the neonate (The Royal Children's Hospital Melbourne, 2014).
- Nasal Cannula: A tube that is split into two prongs, which delivers oxygen into the nasal passages (The Royal Children's Hospital Melbourne, 2014).
- Endotracheal Intubation: A machine that delivers pressure and oxygen into the lungs, which can also assist in breathing for the patient (McCance et al., 2014).
- Guidelines: An evidence-based set of recommendations that is used in practice to help nurses and providers follow a certain set of steps in a clinical circumstance (Ebling Library, 2017).
- Protocol: A predetermined set of recommendations that defines specific nursing interventions for a patient condition in a defined area (Ebling Library, 2017).

- Respiratory Alkalosis: Occurs with alveolar hyperventilation and decreased concentration of plasma carbon dioxide (McCance et al., 2014).
- Metabolic Acidosis: Occurs when the concentration of non-carbonic acids increases or bicarbonate is lost from the extracellular fluid or cannot be regenerated by the kidney (McCance et al., 2014).
- Hypocapnia: Decreased plasma concentration of carbon dioxide (McCance et al., 2014).
- Hyperoxemia: Increased plasma concentration of oxygen (Gershengorn, 2014).

Related Lung Pathophysiology and Physiology

In normal anatomy and physiology of the developing fetus, the lungs are a dense structure up until the second trimester of pregnancy, when they start to lose interstitial tissue to make room for the air pockets known as alveoli (McCance et al., 2014). During this time in utero, the capillaries in the lungs grow to help increase the surface area for gas exchange and undergo differentiation into either Type I or Type II cells (McCance et al., 2014). Type II cells are cuboidal and contain the storage and secretion of surfactant (McCance et al., 2014). Type I cells form the thin layer over the capillaries helping to make the air-blood barrier (McCance et al., 2014). While both cells are very important, Type II cells contain the surfactant which maintains alveolar expansion, therefore helping in gas exchange between the inhaled air and the needs of the body (McCance et al., 2014).

Surfactant lines the alveoli to help decrease the surface tension and prevent the alveoli from collapsing in between each breath (McCance et al., 2014). If there is a lack

of surfactant or the lungs have fluid in them, the surfactant is unable to adequately keep the alveoli open, which leads to increased work of breathing for the neonate. If the neonate is born prematurely, they are at higher risk for surfactant deficiency because it is distributed throughout the lungs starting at 30 weeks of gestation (McCance et al., 2014). Surfactant deficiency is called Respiratory Distress Syndrome (RDS) (McCance et al., 2014).

Normal Neonatal Transition to Extra-uterine Life

As the fetus approaches term gestation, various fetal hormonal fluctuations occur that support the transition of the fetus to extra-uterine life. One hormonal fluctuation that happens at the start of labor is a decrease in fetal pulmonary fluid (Hacker et al., 2016). Decreased fetal pulmonary fluid is noted by the fetus not taking breaths during labor on ultrasonography (Hacker et al., 2016). This decrease in pulmonary fluids is thought to help assist the fetus with retaining surfactant, which is vital in extra-uterine ventilation (Hacker et al., 2016). The stress of labor also triggers another hormonal fluctuation, which is the release of catecholamines (Hacker et al., 2016). Catecholamines are responsible for mobilization of glucose, reabsorption of lung fluid, alterations in perfusion of organ systems, and possible onset of respirations in the extra-uterine life (Hacker et al., 2016). The catecholamines are released from the fetus's adrenal glands, which send hormonal signals to the brain communicating to the body to switch circulatory patterns, engage glucose storage units, and absorb fluid in the lungs to assist with ventilation (Ronca, Abel, Ronan, Renner, & Alberts, 2006).

As the neonate is descending through the birth canal there is compression of the thoracic cage, which is soft because the bones are still being ossified making the thorax collapsible (McCance et al., 2014). The more premature the neonate is the softer their thoracic cage (McCance et al., 2014). From the compression of the thoracic cage amniotic fluid is driven out of the nasal and oral pathways (McCance et al., 2014). As the head emerges, the neonate inspires within a few seconds. The first inspiration increases the pressure in the pulmonary system to help expel the residual amniotic fluid (Hacker et al., 2016). Thus, when inspiration happens, the diaphragm draws downward pulling the chest wall in (McCance et al., 2014). It takes more strength to exhale, so the accessory muscles in the intercostal and supraclavicular spaces are used to assist the diaphragm (McCance et al., 2014). If there is fluid, meconium, or the lungs are immature, the accessory muscles will have to work harder to pull that diaphragm up to exhale (McCance et al., 2014). Therefore, the retractions from the accessory muscles are an indicator that the neonate is having increased work of breathing.

Complications from Transition to Extra-uterine Life

If the woman is not able to or chooses not to have a vaginal delivery, the body may not go through labor. The neonate may not experience the stress of labor that induces the beneficial release of catecholamines and decrease of fetal pulmonary fluid, both of which assist with the transition to extra-uterine life (Hacker et al., 2016). This, along with the lack of compression from the vaginal canal, increases the likelihood the neonate may need supplemental oxygen (Hacker et. al., 2016). If the neonate is born prematurely due to medical reasons such as abruptio placenta, placenta previa,

incompetent cervix, pregnancy-induced hypertension, low amniotic fluid, preeclampsia, intrauterine growth restriction, or premature rupture of membranes, the neonate is at an increased risk of having respiratory distress (Hacker et al., 2016).

Nursing Management of Neonates with Respiratory Difficulties

Increased work of breathing or apnea in the neonate can be caused by premature lungs which can be a result of inadequate levels of surfactant, or fluid or meconium in the lungs. Oxygenation and pressure supplementation from an oxygen modality is needed to support the neonate's respiratory deficiencies. If the neonate has RDS, the proper medication is also needed to be given to address the lack of surfactant (Hacker et al., 2016). The proper medication is a steroid called Betamethasone that can be given to the mother before birth (Hacker et al., 2016). This steroid medication needs to be given in two doses (Hacker et al., 2016). If there is not enough time to give the correct dosage to the mother prior to delivery, surfactant can be given through an endotracheal tube to the neonate (Hacker et al., 2016).

Two ideal choices when the neonate is having increased work of breathing are CPAP and HHFNC because they provide both pressure and oxygen that is heated and humidified (Milesi et al., 2014). Pressure helps the alveoli stay open, allowing gas exchange to occur (Milesi et al., 2014). Also, increasing the pressure in the lungs assists in decreasing the pressure in the pulmonary vein, which helps the neonate transition from fetal circulation to extra-uterine circulation (McCance et al., 2014). A CPAP can deliver oxygen and pressure through nasal prongs in the nares, a mask that covers the mouth and nares, or a mask that just covers the nares (Kim et al., 2016). A HHFNC delivers oxygen

and pressure through prongs, similar to a low-flow oxygen cannula, through the nasal passage (Milesi et al., 2014). A HHFNC uses shorter prongs that have been shown to be more comfortable and less invasive for the neonate (De Paoli et al., 2008). There are also perceived and shown advantages of HHFNC as opposed to CPAP, such as cost effectiveness, easier oral feedings, reduction in nasal trauma, and neonate pain-score reduction (Roberts & Hodgson, 2017). Some authors found HHFNC to have the same efficacy as CPAP when used at 3L or higher (Wilkinson et al., 2016, & Spence, Murphy, Kilian, McGonigle, & Kilani, 2007). In the same studies, HHFNC has been regarded as an alternative to the use of CPAP to support neonates in respiratory distress (Spence et al., 2007, & Wilkinson et al., 2016). Using HHFNC can provide benefits for the neonate, but can also result in significant, undesirable sequelae if not used properly.

If HHFNC is not managed properly, pressures provided may be too high and cause deleterious effects such as air-leak syndromes (Jeng, Lee, Tsao, & Soong, 2012). Air-leak syndromes include pneumothorax, pulmonary interstitial emphysema, pneumomediastinum, pneumopericardium, and subcutaneous emphysema (Jeng et al., 2012). These syndromes can be due to biological factors such as meconium aspiration or prematurity (McCance et al., 2014). Also, they can occur when the pressure of the oxygen modality is too high or there is inadequate ventilation (Jeng et al., 2012).

If the HHFNC has too high of pressures, this causes the alveoli to burst (Jeng et al., 2012). The extra air from the burst alveoli then infiltrates in between the lung parenchyma and chest wall (Jeng et al., 2012). The infiltrated air creates more resistance for lung expansion and causes the alveoli to stay open, increasing inspiratory effort (Jeng

et al., 2012). Therefore, the neonate cannot ventilate the body with the amount of oxygen required for extra-uterine life (Jeng et al., 2012).

If the neonate is inadequately ventilating, the neonate's body goes into a metabolic acidotic state due to compensation by the kidneys releasing bicarbonate to try and normalize the pH (McCance et al., 2014). Another compensatory mechanism is for the neonate to start ventilating faster to try get enough oxygen required for the body (McCance et al., 2014). Since the neonate is ventilating faster, they are taking shorter, shallower breaths causing hyperventilation. Since the neonate's body is in a hypoxic state, there is little carbon dioxide exchange, which causes hypocapnia (McCance et al., 2014). Hypocapnia is decreased plasma carbon dioxide in the blood stream (McCance et al., 2014). The result of the acid base shift, caused by hypocapnia, is called acute respiratory alkalosis (McCance et al., 2014). The HHFNC can help fix acute respiratory alkalosis by decreasing the pressure or increasing the FiO2 given by the oxygen modality (McCance et al., 2014). By decreasing the pressure it will let the alveoli inflate and deflate allowing oxygen and carbon dioxide exchange (McCance et al., 2014). Also, turning up the FiO2 will increase the oxygen in the neonate's body; they will stop hyperventilating and start taking deeper ventilations, allowing carbon dioxide and oxygen exchange (McCance et al., 2014).

The diagram below is an algorithm on respiratory alkalosis including the different compensatory mechanisms.

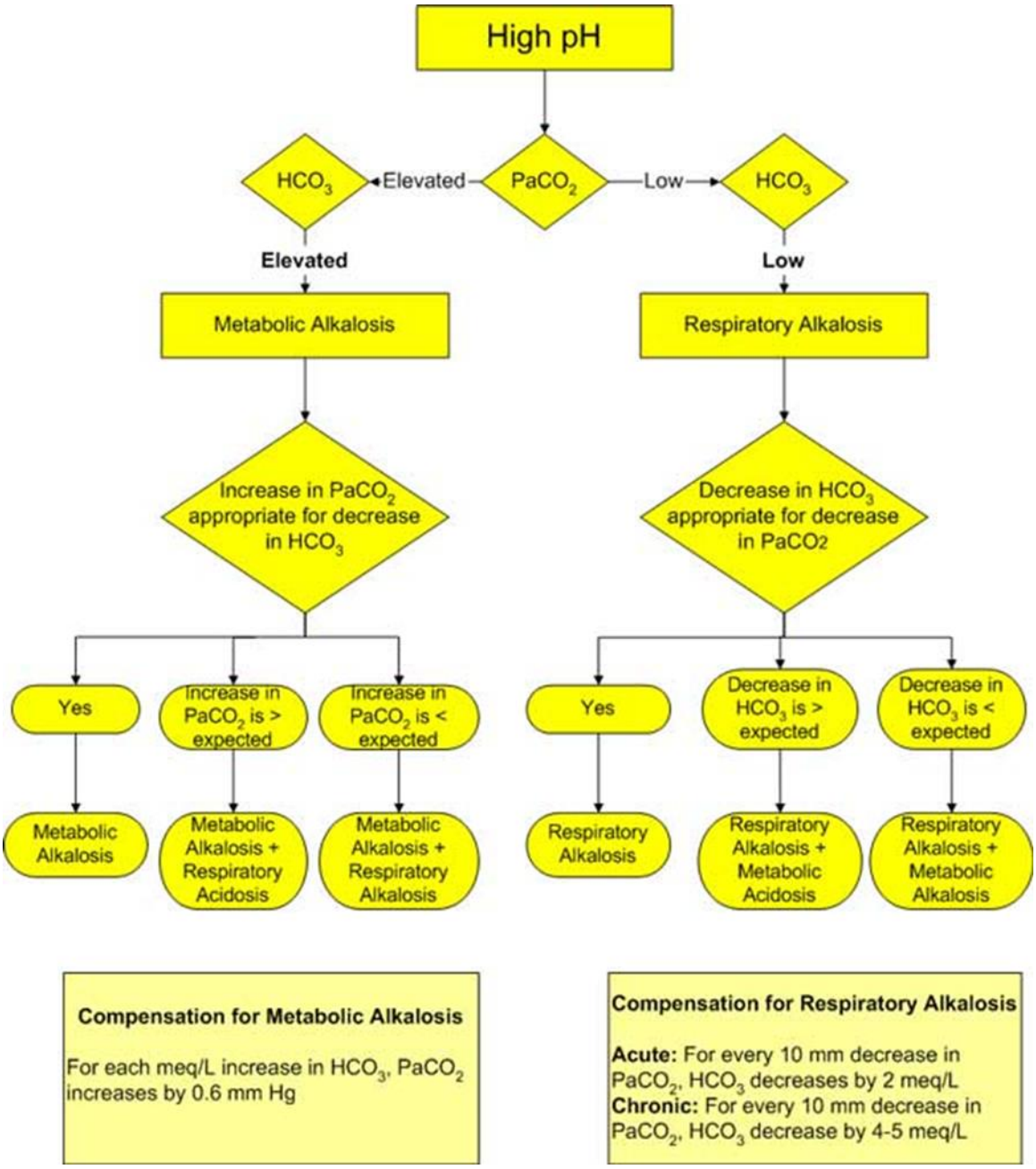


Figure 1. Respiratory Alkalosis (Medlibes, 2010)

Another important issue with using HHFNC is avoiding hyperoxia (Donn & Sinha, 2006). Hyperoxia is caused by too much oxygen that damages the lungs due to the free radicals causing the lung parenchyma to inflame (Winslow, 2012). The oversupply

of oxygen causes vasoconstriction, which increases the pulmonary pressures leading to less circulated oxygen to perfuse the body (Winslow, 2012). If the neonate is in a hyperoxic state, this creates hyperoxemia (Gershengorn, 2014). Hyperoxemia leads to increased ATP use and increases the vascular pressure, which can lead to seizures, induce cerebral vasoconstriction causing neuronal cell death, and decrease the heart rate (Gershengorn, 2014).

There was no data found that states an exact incidence of these complications caused by HHFNC. Since HHFNC is comparable to CPAP, research has shown that it is possible to get these deleterious effects from either HHFNC or CPAP as both devices work similarly. Also, HHFNC has no set guidelines for use in the term and preterm population (Sasi & Malhorta, 2016, & Gibson & Nawab, 2015).

With these serious potential complications that preterm and term neonates can experience, their care needs to be carefully monitored. Of particular concern are consequences that can result from HHFNC not being managed properly such as pneumothorax, pulmonary interstitial emphysema, pneumomediastinum, pneumopericardium, subcutaneous emphysema, or hyperoxia and hypocapnia (Sasi & Malhorta, 2016, & Gibson & Nawab, 2015). Physicians generally manage the care of neonates on CPAP, but in some institutions, the management of HHFNC can be left to the nurses' or respiratory therapists' (RT) discretion, when ordered by the physician. For these reasons, a nursing protocol on how to manage neonates on HHFNC to prevent these complications is advised.

Benefits of Nursing Protocols

Currently, there are no formal guidelines for HHFNC use in the term and preterm population. A guideline is used universally and can be found on the National Guideline Clearinghouse (NGC) (Agency for Healthcare Research and Quality [AHRQ], N.D.). A protocol is a set of steps that each hospital's research team has created, and these can be different at any hospital (Ebling Library, 2017). Since there is no guideline for term and preterm neonates using HHFNC using evidence-based literature is the best way to formulate a protocol. A protocol is important because it guides providers and nurses with specific instructions on how to initiate, manage, and wean the HHFNC (Graham & Harrison, 2005). It will also help with improving quality of care and improving patient outcomes when using HHFNC (Graham & Harrison, 2005).

According to Woolf, Grol, Hutchinson, Eccles, and Grimshaw (1999), hospital polices are made to "improve quality of care to patients." Woolf et al. (1999) defined the benefits to patients as improved health outcomes, decreased morbidity and mortality, and consistency of care. Protocols help reduce ineffective care, help healthcare professionals make consistent decisions, support quality improvement projects, and provide evidence by research of interventions with proven increased effective care (Woolf et al., 1999).

Lunden, Teras, Kvist, and Haggman-Laitila (2017) found that there are factors that facilitate and inhibit disseminating evidence-based literature associated with the competent nurse or nurse leader. Lunden et al. (2017) state that "competency means more than having skills or qualifications required by a task. It also comprises attitudes, motivation, insight, interpretive ability, receptiveness, maturity, and self-assessment."

(Lunden et al., 2014). These authors were trying to find what kept nurses and nurse leaders from reaching this level of competence. What Lunden et al. (2017) found, along with Flogren, Parmelli, Doumit, Gattellari, O'Brien, Grimshaw, and Ecceles, (2014), was that disseminating evidence-based literature is multifactorial. Flodgren et al. (2014) found that, if there is more than one leader trying to disseminate evidence-based literature along with organizational help, it is more effectively shared. Lunden et al. (2017) found that the two main influences in sharing evidence-based literature were organizational structure and nursing leadership. The two inhibiting influences on sharing evidence-based literature were organizational culture and management of human resources (Lunden et al., 2017).

In conclusion, nursing leaders and researchers have developed individualized protocols for facilities where they work to assist in nursing management of HHFNC. These individualized protocols are not set, standard guidelines for every facility to use; they are a predetermined set of recommendations as opposed to guidelines, which are evidence-based recommendations that follow a certain set of steps in a clinical circumstance (Ebling Library, 2017). Using these protocols along with more evidence-based literature will increase the competence of the nurse, decrease morbidity and mortality, increase health outcomes, and provide consistency of care.

Local Problem

Currently, in a rural, centrally located, special-care nursery (SCN), the use of HHFNC has become more frequent because of the perceived positives of cost effectiveness, easier oral feedings, reduction in nasal trauma, and neonate pain score

reduction (Roberts & Hodgson, 2017). Upon looking into the statistics of negative outcomes due to oxygen modalities in that unit, there were four pneumothoraces that were coded in the year 2017 (Knapp & Nelson, 2018). These data were derived by the coding specialist at the rural, centrally located hospital who found the specific ICD-10 code of J93.7. This code is specific for pneumothorax diagnosis. The coding specialist was not able to provide specific details on whether the neonate was on CPAP or HHFNC, but could specify that the neonate was on a breathing modality with more than two liters of flow (Knapp & Nelson, 2018). Next, there are two codes for dependence on supplemental oxygen or other enabling machines and devices, which are Z99.81 and Z99.89. Using these codes would help to find how many neonates needed supplemental oxygen throughout the year of 2017. Unfortunately, these codes were not found in the year of 2017 (Knapp & Nelson, 2018). The coding specialist could not provide any other information about the neonate without going through each chart individually for 2017.

The fact that there were four pneumothoraces during 2017 doesn't necessarily indicate whether there were other complications due to misuse of HHFNC. Since no other codes were used to show dependence upon supplemental oxygen, it is hard to determine how many neonates were on HHFNC, low-flow oxygen, or CPAP.

To better understand the local problem, a fishbone analysis was designed to help recognize the subjects and their part in the misuse of high flow.

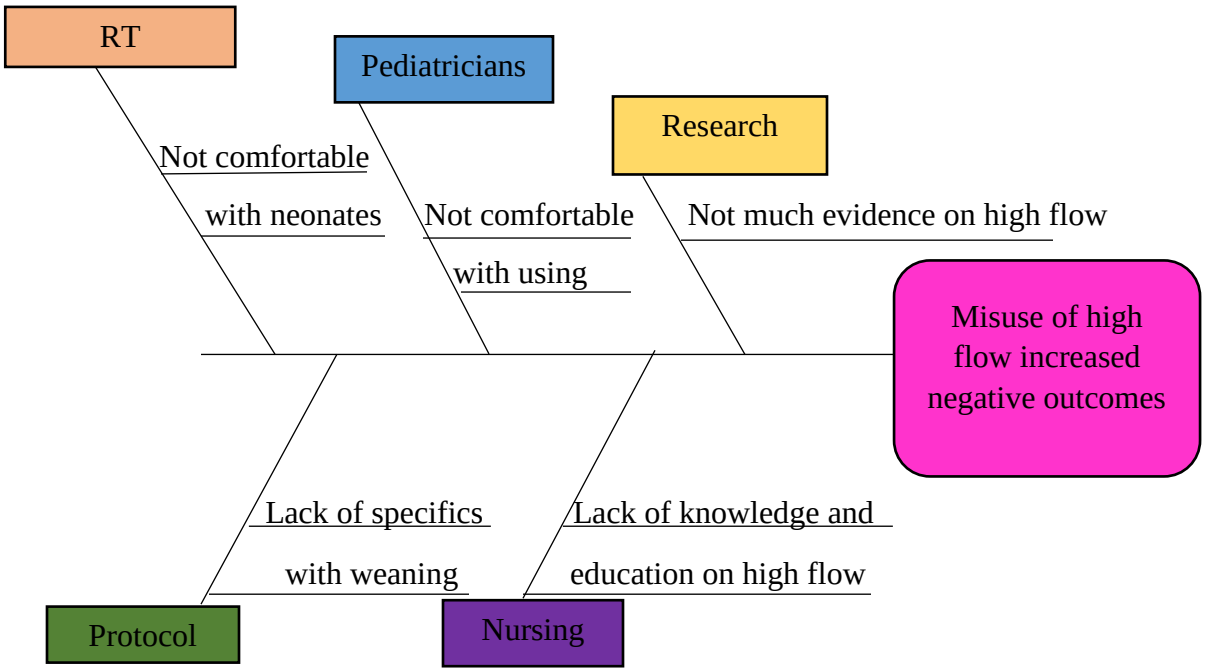


Figure 2. Fishbone to Help Analyze Misuse of HHFNC

Through the fishbone analysis, five key subjects were identified—the respiratory therapists (RT), current policy, research, pediatricians, and nursing—all of whom have the potential to misuse HHFNC. Currently, some of the RTs at the rural, central located hospital are uncomfortable with using HHFNC on neonates due to lack of training and experience. The pediatricians haven't had any formal education on HHFNC, so do not feel as confident about how to properly use the oxygen modality. The current policy doesn't state specifics on how fast to wean FiO2, how often vital signs should be taken, whether chest imaging needs to be taken, or whether labs need to be drawn. The nursing staff has not had formal training or teaching with HHFNC. Finally, there is little published research and no formal guidelines on HHFNC for the term and preterm neonate

population. With the possible risk of misuse by the five key subjects identified, it is evident HHFNC has the potential to be misused.

How to Revise a Protocol

The first step for revising protocols, according to Patient Safety and Quality Healthcare (2017), is to research the current literature that is provided for the area of concern. For this project, the problem area is looking at the current protocol and comparing it to the current literature to see if it is up-to-date. The current protocol used in this rural, centrally located SCN is based on one study by Yoder, Stoddard, Li, King, Dirnberger, and Abbasi (2013). The next step is to analyze the studies that are in the current protocol and other evidence-based literature that may be more recent (PSQH, 2017). While researching the pertinent information, a key concept to keep in mind is associations or facilities who may have recommendations, but they do not have to be followed by every institution (PSQH, 2017). In the event an institution doesn't follow pertinent recommendations, the institution is putting itself at higher risk to succumbing to lawsuits (PSQH, 2017). Upon finishing the protocol, it is then to be presented to the appropriate committees that will have to approve it (PSQH, 2017). While the approval committees are looking over the revised protocol, the institution needs to update the staff that is affected by the revised protocol (PSQH, 2017).

Purpose Statement

The first purpose of this project was to assess the current SCN nurse's knowledge about HHFNC and evaluate any learning needs. The second purpose of this project was to revise the current HHFNC protocol (Appendix A) in the SCN to help inform the primary users how to properly use and assess the neonate on HHFNC. To do this, a review of literature and protocols from larger facilities were reviewed to provide the latest, evidence-based information. This purpose is supported by the evidence of the literature to be discussed.

CHAPTER TWO

REVIEW OF LITERATURE

Synthesis of Evidence

Databases were extensively reviewed using the Cochrane Library, CINAHL complete, and Pubmed. The search terms were “neonates and oxygen,” “neonates and high flow nasal cannula,” “cpap and high flow nasal cannula,” and “neonates on high flow nasal cannula.” The inclusion criteria were set with articles up to 10 years old and only in English. Articles that were reviewed were systemic reviews, random control studies, expert opinion, and controlled cohort studies. These current studies were organized and placed into an evidence-based table (Appendix B).

Oxygen Modality

Two cohort studies by O’Donnell et al. (2010) and Heiring, Steensburg, Bjeragr, and Greison (2015) found that the use of CPAP did not make a difference in the length of stay or find a benefit in using low-flow nasal cannula after CPAP was discontinued. Heiring et al. (2015) found that weaning 52 preterm neonates and O’Donnell et al. (2010) found that switching 72 neonates from CPAP to room air did not increase respiratory distress as compared to placing them on low-flow oxygen after CPAP was discontinued. O’Donnell et al (2010) also found that weaning from CPAP to room air did not increase length of stay. A randomized-controlled study by Abel-hardy, Aly, and Shouman (2010) found no difference or increased length of stay when the preterm neonate was weaned

from CPAP to room air. Lastly, a systemic review by Amatya, Bhutada, Rastogi, and Rastogi (2015) of premature neonates found that weaning to room air from CPAP or HHFNC was adequate for the premature neonate, and they do not require a low-flow oxygen device.

Two systemic reviews by Wilkinson, Andersen, O'Donnell, De Paoli, and Manley (2016) and Greenough and Sharma (2010) found that HHFNC is just as effective as a respiratory modality as CPAP. Wilkinson et al. (2016) reviewed 15 different studies that focused on HHFNC and CPAP. Those authors found that HHFNC seems to have the same outcome and length of stay as CPAP. Greenough and Sharma (2010) found that in over 2000 studies performed on various kinds of respiratory modalities, HHFNC and CPAP had the same efficacy in use. In a cohort study by Sasi and Malhorta (2014), the authors found that, in neonates with chronic lung disease, the outcome was the same when using either respiratory treatment; HHFNC or CPAP. Also, if the neonates were on either respiratory modality, they had the same length of time and required the same amount of care (Sasi & Malhorta, 2014).

De Paoli, Davis, Faber, and Morley (2008) found that using short binasal prongs was more effective in delivering oxygen and providing adequate pulmonary pressures to the neonate. The researchers also found the shorter binasal prongs were able to provide more comfort for the infant and decrease irritation on the nasal passage and mucous membranes (De Paoli et al., 2008). The prongs also decreased the dead space in the nasopharyngeal area, which allowed for adequate pressures to be delivered to the lungs (De Paoli et al., 2008).

A randomized-controlled study performed by Yoder, Stoddard, Li, King, Dirnberger, and Abbasi (2013) found that, in neonates who were initially started on CPAP or HHFNC when they initially presented with signs of respiratory distress or post extubation, the two oxygen modalities had similar efficacy in use (Yoder et al., 2013). The authors started with determining the size of nasal prongs for the HHFNC, which was about 50% of their nare size, and flow rate was determined by the weight of the neonate (Yoder et al., 2013). Miller (2012) concurred with Yoder et al. (2013) that it was more beneficial to have 50% or less of the nares occluded because, if they take up more than 50% of the nares, this would cause increased pressures in the lungs and nasopharyngeal space. Yoder et al. (2013) initiated HHFNC flow at 3L/min up to 5L/min if FiO2 was increased more than 10% of starting FiO2, decreased lung expansion as shown by chest x-ray, increased respiratory distress or retractions, and/or increased partial carbon dioxide (pCO2). Flow was decreased by 0.5-1L/min increments if FiO2 was maintained less than 30%, pCO2 stayed the same or improved, lung expansion was deemed adequate, and no signs of respiratory distress for a four-hour period (Yoder et al., 2013). Miller (2012) also stated that there was little to no benefit to the neonate for the HHFNC to be lower than 2L/min. The dead space is washed out with a higher literage replacing noxious air with oxygenated air (Miller, 2012). Replacing the noxious air in the dead space allowed the neonate to breath in oxygenated air (Miller, 2012).

Lastly, a cohort study of 14 neonates done by Spence, Murphy, Kilian, McGonigle, and Kilani (2007), found HHFNC delivered adequate pressures in the lungs at 3L/min or greater. This liter flow gave adequate pressures comparable to CPAP. The

authors also found that, if HHFNC was at 1-2L/min of oxygen, it would not provide the pressures required to keep the lungs open to oxygenate the neonate (Spence et al., 2007).

In summary, based on the literature review, HHFNC and CPAP have comparable efficacy when used properly (Wilkinson et al., 2016, and Greenough & Sharma, 2010). Using the short binasal prongs for HHFNC helped provide the proper pressures to ensure that the neonate gets adequate oxygenation (De Paoli et al., 2008, & Miller, 2012). Neonates being treated with HHFNC or CPAP have similar length of stay and HHFNC can provide the same amounts of pressure when set at 3L/min or higher (Sasi & Malhorta, 2014).

Policies and Nurses

Woolf et al. (1999) state that, if the development of clinical guidelines is derived from evidence-based literature, it minimizes potential harms such as patient mortality and morbidity, decreased health outcomes, and inconsistency of care. Lunden, Teras, Kvist, and Haggman-Laitila (2017) found two factors that were influencing the advanced practice nurses (APN) and registered nurses (RN) and two factors that were inhibiting them from learning evidence-based literature. The two influencing factors that had the biggest impact on learning evidence-based literature were organizational structure and nursing leadership (Lunden et al., 2017). These factors helped encourage the APNs and RNs to learn and apply evidence-based literature. If the APNs and RNs are learning what the evidence-based literature says, it will increase the chances of future clinical guidelines or protocols being produced from evidence-based literature.

In a second study, Flogren et al. (2014) found that, if one leader taught evidence-based literature, it made a small impact, but if multiple leaders taught evidence-based literature, there was a larger impact on the whole unit (Flogren et al., 2014). Flogren et al. (2014) also found, when there were more influencing factors for evidence-based literature, there was more success of having learning needs being met.

One last study by Melnyk Mazurek, Gallagher-Ford, Long, and Fineout-Overholt (2014) found that there were 13 competencies for RNs and 11 for APNs on using evidence-based literature and incorporating them into their practice. As Melynk Mazurek et al. (2014) state, "competencies are a mechanism that support health professionals in providing high quality, safe care." These competencies translate to clinical guidelines or protocols by increasing quality and safety of care taught to the medical staff that is working with the RN or APN.

In summary, Woolf et al. (1999) state that clinical guidelines are important to have because they help provide consistent care, improve patient outcomes, and decrease mortality and morbidity rates. Tying in, Melnyk Mazurek et al. (2014) and Flogren et al. (2014), state there needs to be a good understanding of evidence-based literature for the RNs and APNs to help devise these protocols to deliver safe, effective care.

Practice Protocols

The larger facilities that the rural, centrally located SCN transfers neonates to for higher level of care, were contacted concerning their practice protocols on HHFNC in the preterm and term neonatal population. Two hospital practice protocols were sent to the author and reviewed. One practice protocol provided by Intermountain Primary

Children's Medical Center (PCMC) (2007) describes assessment criteria as heart rate, blood sugar, pulse oximetry, chest x-ray, disease process, and patient history. This protocol lists exclusion criteria of active pneumothorax and abdominal surgeries (PCMC, 2007). This policy goes by an algorithm. It starts with extubation, then asking if the neonate is in a study, and then if the neonate is requiring distending pressure (PCMC, 2007). If the neonate isn't requiring distending pressure, it states to set up low-flow nasal cannula. If the neonate is requiring distending pressure then to set up for intubation. Next is to reassess the neonate to evaluate if the current oxygen therapy is meeting their oxygen needs (PCMC, 2007). If the neonate is still in respiratory distress, the oxygen therapy will need to be changed or increased; if they have decreased respiratory distress, the oxygen therapy may stay at its current therapy (PCMC, 2007). If the patient is requiring distending pressure, it asks for how long has the patient been on ventilation. If longer than seven days, it states to use CPAP; if shorter than seven days, HHFNC is to be started (PCMC, 2007). The protocol states to start the HHFNC at 2L/min and start FiO2 at the same level the neonate previously required, and then to reassess the patient (PCMC, 2007). If the neonate is improving by assessment findings based on predetermined criteria, is at 30% FiO2 or less, then the HHFNC can be decreased 0.5L/min to 1L/min every 12 hours (PCMC, 2007). If the neonate weighs <1000 grams and on <1L/min, weighs 1500 grams and on <1.5L/min, or weighs <5kgs and on <2L/min and stable with inclusion criteria, then the HHFNC can be switched to a low-flow nasal cannula with reassessments (PCMC, 2007). Overall, this algorithm provides

an easy flow for a healthcare professional to follow, states inclusion and exclusion criteria, and when to notify the provider.

Additionally, there is another protocol by Seattle Children's Hospital called Humidified High-Flow Nasal Cannula and Nasal Continuous Positive Airway Pressure: Use in Community Hospital NICUs. In this protocol, the author demonstrates with graphs of the pressures delivered through HHFNC and its effectiveness (Wallen, 2015). The author acknowledges the use of CPAP, but displays how HHFNC and CPAP are comparable oxygen modalities. Wallen (2015) states that the neonate should be started on 3L/min of flow if 32-34 weeks' gestation, 4L/min of flow with 34-36 weeks of gestation, and 4–5L/min of flow if the neonate is greater than 36 weeks of gestation, with a maximum flow of 6L/min. If the neonate starts to show signs of respiratory distress, such as respirations greater than 80, retractions, grunting, and nasal flaring, then it states the FiO2 can be increased up to 40% (Wallen, 2015). If the neonate is at a persistent FiO2 of 40% and had the maximum of 6L/min, then it states to consider switching to CPAP (Wallen, 2015). If there are improvements in the neonate's respiratory status, such as respiratory rate less than 80, adequate lung expansion, maintaining oxygen saturations with FiO2 less than 30% for four or more hours, then start weaning flow in 1L/min increments (Wallen, 2015). The neonate can be weaned to room air or low-flow oxygen if they are tolerating the pressure and oxygen wean with no increased work of breathing and they have adequate lung expansion when HHFNC is 1L/min (Wallen, 2015).

Theoretical Underpinning

The theory used to guide this project was Casey's Model of Nursing. This theory was developed in 1988 by Anne Casey who was an English nurse (Petiprin, 2016). Casey states that nurses should work side-by-side with families when working in neonatal and pediatric care (Petiprin, 2016). There are five concepts in this theory: the neonate, health, family, environment, and the nurse (Petiprin, 2016). Casey thought that the best people to care for the neonate or pediatric patient were the family, with the medical professionals assisting them. This philosophy made a relationship between the nurse and family essential to the neonate or pediatric patient's care. In this project, the aspects from this theory that will be focused on are the neonate, their environment, and the nurse. For the nurse to be able to work with weaning the oxygen off the neonate, the nurse will have to monitor the neonate closely using protocols or clinical guidelines. The nurse is also trying to work with the families to make schedules on when to allow for bonding times. The nurse and families will have to focus on what causes the least amount of stress in the neonate's environment.

CHAPTER THREE

METHODS

Overview

The purposes of this project were to assess the current SCN nurses' knowledge of HHFNC and to revise the current protocol that was in place. To evaluate the SCN nurses' knowledge, a survey was comprised and emailed to them via their work emails. Upon receiving the survey, the SCN nurses had three weeks to complete it. After the completed surveys were received, the data was quantitatively analyzed to identify where there were learning needs. After identifying the learning needs, the current HHFNC protocol was revised with the help of evidence-based literature and larger facility protocols. After meetings with the SCN educator, it was found that the protocol was adequate, but the learning needs identified from the surveys completed by the SCN nurses needed to be formally addressed. Upon reviewing larger facility protocols, the RT manager at Seattle Children's offered to do a one-hour live seminar on how to manage HHFNC for term and preterm neonates. The SCN educator and one of the pediatricians who works in the SCN agreed that this would be beneficial. The RT manager at the rural, centrally located hospital thought it would be beneficial for the respiratory therapist to also participate in the seminar. The seminar was held at the rural, centrally located hospital in a meeting room on May 24, 2018. People who attended were six SCN nurses, three pediatricians, and five RTs from the rural, centrally located hospital. After the one-hour seminar, a

visual slide presentation, which was led by this author was presented to the SCN nurses to review results of the survey and demonstrate how to find and use the current protocol.

Setting

This project was conducted in the SCN in a rural, centrally located hospital. The SCN is defined by the American Academy of Pediatrics (AAP) as a unit that will take neonates 32 weeks or older in gestation, can provide mechanical ventilation for brief durations (<24 hours) or continuous positive airway pressure, and has the appropriate personnel available for emergency situations (AAP, 2004). This rural SCN delivers more than 1,200 neonates a year (Bozeman Health, 2018). There are a total of 11 tables and Isolette beds in the SCN prepared to handle neonates who need more specialized care.

Protection of human rights was maintained by obtaining approval from Montana State University's (MSU) International Review Board (IRB) along with approval from the rural, centrally located hospital's institutional review board.

There were 23 associate- or baccalaureate-prepared, registered nurses who worked in the SCN. These 23 nurses were all females and were employed for the duration of this project. Names and email addresses of nurses who were surveyed were obtained through a list provided by the SCN nurse educator. Only the SCN nurses' emails were obtained for the purpose of this project.

Data Collection

This project was initially started by assessing the baseline knowledge about the management of HHFNC on the nurses working in the SCN. The survey was formatted

through SurveyMonkey and was comprised of 10 multiple choice questions that were formulated through evidence-based literature and knowledge from a neonatal nurse practitioner (NNP) experienced in HHFNC (Appendix C). The survey first addressed the respondent's length of nursing career and how long they have worked with neonates. Next, their knowledge of HHFNC was assessed by asking about assessment of the neonate receiving HHFNC, their current knowledge on how to increase and decrease the device's flow and FiO2 levels, how to address parents about the device, and how to foster the parent-child bond when the neonate is on HHFNC.

The email provided to the nurses presented information about the background and purpose of the survey. It also followed Bonnel and Smith's (2014) recommendations of including: why they were chosen for the survey, author's contact information, that they had the right to ask any questions concerning the project and survey, that they had the right to refuse to take the survey, and that confidentiality was assured. Confidentiality was maintained by having the surveys anonymous through the SurveyMonkey website and by having no personal details of the respondents required. The survey was sent electronically on May 1, 2017 to the nurses' email addresses. As a reminder to the nurses to complete the survey, flyers were posted in areas that the nurses frequented. There was a reminder email sent to the nurses on May 8, 2017. The nurses were given a total of three weeks to complete the survey. The survey was officially collected and closed on May 22, 2017.

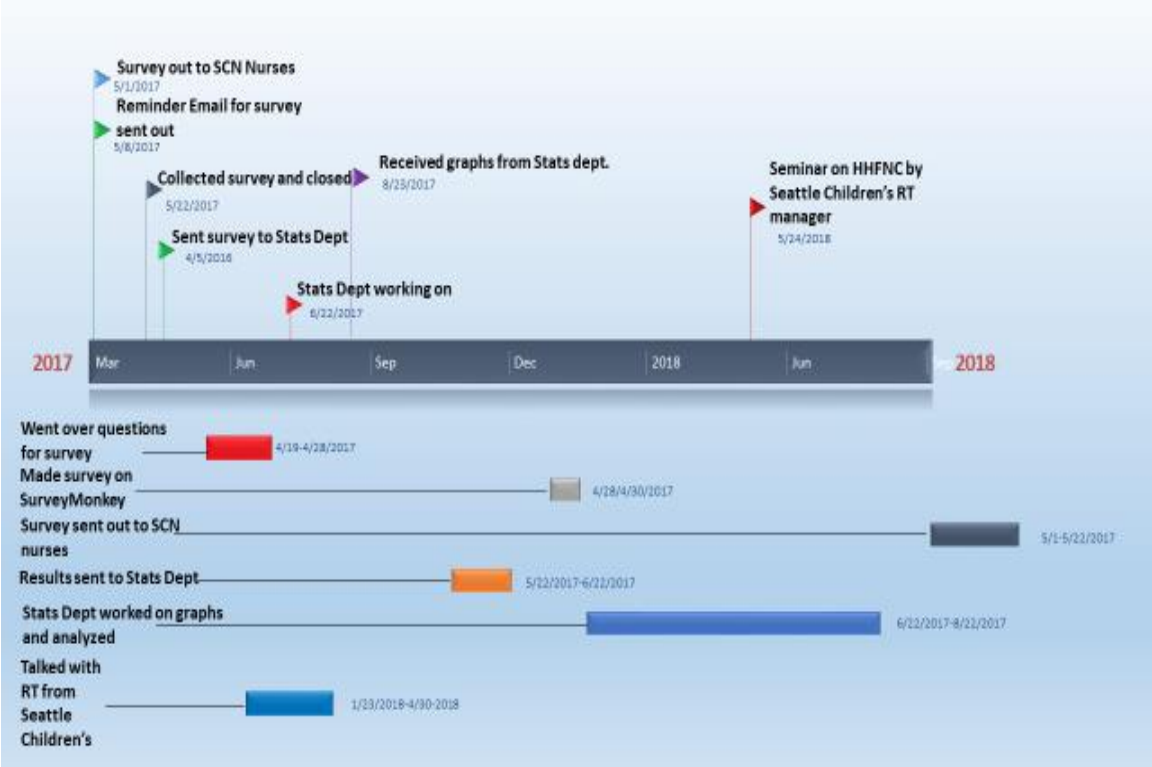


Figure 3. Timeline for Survey and Seminar

Data Analysis

The Department of Mathematical Sciences at MSU was consulted and helped analyze the data. The results of the survey were used to determine the learning needs of the nurses regarding the management of neonates on HHFNC. The survey information was used, along with the review of literature and two larger facilities' protocols, to help form a revised, evidence-based protocol for the rural SCN.

Development of New Protocol

The author reviewed protocols that were found in larger facilities, Intermountain Children's Primary Medical Center and Seattle Children's. Along with using the review of literature and the current protocol, which were all referenced for assistance when

developing the revised, evidence-based protocol for the SCN. The RT managers at these two hospitals were contacted via phone and requested to share their hospital's protocol on NICU HHFNC pertaining to this project. After speaking with the RT manager at Seattle Children's Hospital, they offered to help put on a seminar on HHFNC for the rural, centrally located hospital. Upon this discussion they were told that this would have to be discussed and approved by the SCN educator. Both of these hospitals were able to email their protocols to the author with purposes of using it for research. A few other hospitals were contacted, but they were reluctant to share their hospital protocol on NICU HHFNC.

The proposed revised protocol was first shared with the SCN educator. Input was solicited from her and modifications were made as recommended by her, as long as the changes remained consistent with evidence-based literature. Upon the second meeting with the SCN educator, there were more modifications recommended along with concerns expressed by the SCN educator of the protocol being too specific for what the hospital's board was recommending for protocols in the SCN. The SCN educator also mentioned that their current protocol was derived from one study (Yoder et al., 2013) that the AAP approved and recommended using. Upon talking in length with the SCN educator, it was determined that the protocol should stay how it is currently written, but the learning needs found from the survey results should be addressed.

Upon discussing how to address the learning needs found, the offer that the Seattle Children's Respiratory Therapy manager had proposed was offered to the SCN educator. After this discussion, the SCN educator and a pediatrician that works in the

SCN agreed it would be a good educational opportunity to have a seminar on the management of neonatal HHFNC. Upon their approval, the RT manager at this rural, centrally located hospital was contacted to see if the RT department would want to be included in this seminar. The RT manager agreed it would be beneficial for their department and welcomed the invitation to participate.

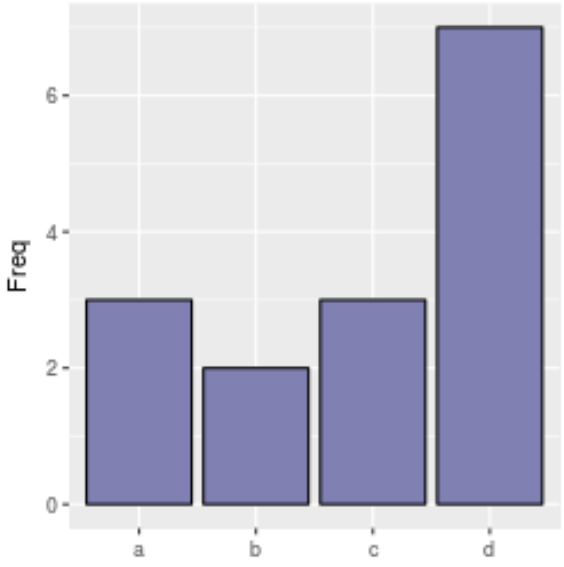
The Seattle Children's RT manager was contacted and agreed to present a one-hour seminar for the SCN, RT department, and pediatricians. The Seattle Children's RT manager worked with a representative from the medical device company Vapotherm who agreed to sponsor the one-hour seminar. The live seminar was delivered via live stream projector in a reserved room in the rural, centrally located hospital on May 24, 2018. The Vapotherm representative recorded the seminar to use for future reference. A visual slide presentation (Appendix D) on the results of the survey and how to find and use the current policy was presented by this author to the attendees of the seminar after the one-hour HHFNC presentation.

CHAPTER FOUR

RESULTS

The survey to assess HHFNC learning needs was emailed to 23 SCN nurses; 15 SCN nurses participated in the survey. Those who participated represented 65% of the population in this rural, centrally located nursery. All the responding participants finished the survey, with no unfinished questions (Department of Mathematical Sciences at MSU, 2017).

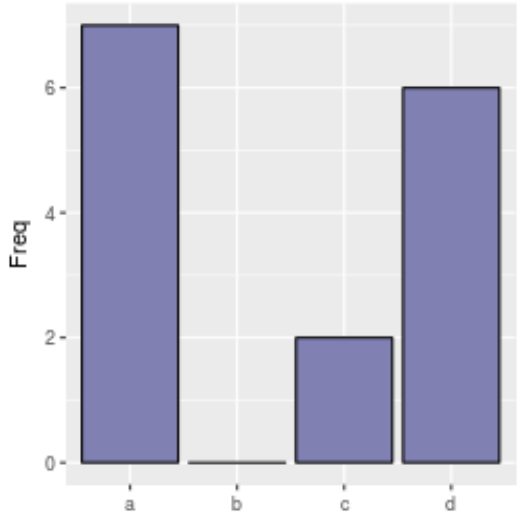
Question one asked how long the nurses had been nurses, with the most prevalent response being over 10 years. Responses 0–3 years and 8–10 years were equal, with 4–7 years receiving the fewest responses.



Label	Answer
a	0-3 years
b	4-7 years
c	8-10 years
d	>10 years

Figure 4. How Long Have You Been a Nurse?

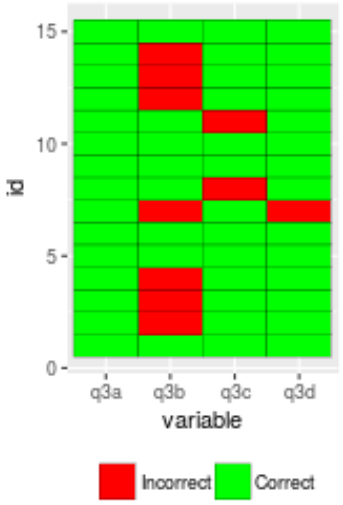
Question two asked how long the nurses have worked in the current nursery. The most prevalent responses were 0–3 years and greater than 10 years, with the fewest responses on 8–10 years and no responses for 4–7 years.



Label	Answer
a	0-3 years
b	4-7 years
c	8-10 years
d	>10 years

Figure 5. How Long Have You Worked in the Current Nursery?

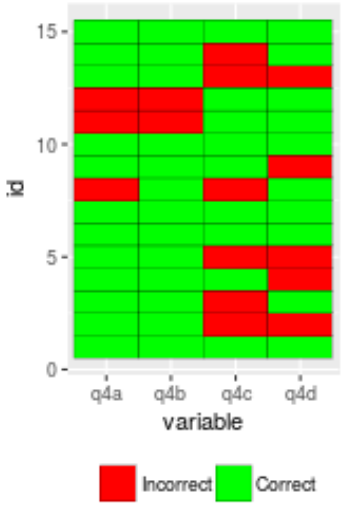
Question three asked when it was appropriate to consider treating a neonate with HHFNC. This question was multiple choice and three out of the four choices were correct. Two of the 15 participants answered with the incorrect option, which was option C. Correct options were A, B, and D.



Label	Answer	Correct?
a	Low flow oxygen is not providing enough support	Correct
b	Infant is having apneic spells	Correct
c	Infant is saturating 90%	Incorrect
d	Infant is just extubated	Correct

Figure 6. When is it Appropriate to Consider Using HHFNC?

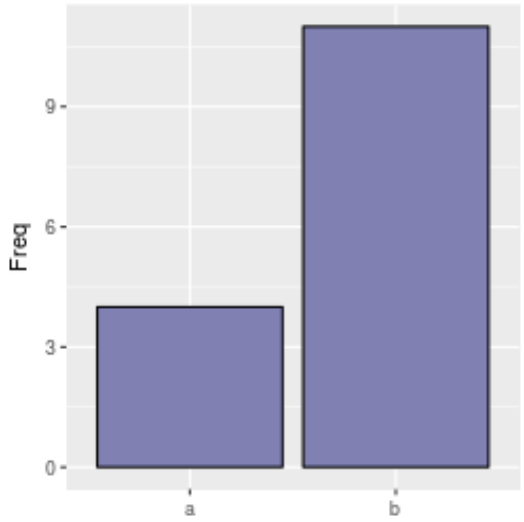
Question four asked, if the neonate is in respiratory distress, what would be the appropriate actions to take, with instructions to choose all that apply. Three out of the four choices were correct. Five of the 15 chose the wrong answer. Options A, B, and C were correct, and D was incorrect.



Label	Answer	Correct?
a	Change infants position	Correct
b	Notify the physician	Correct
c	Turn Fi02 up	Correct
d	turn flow down	Incorrect

Figure 7. What Would be Appropriate Actions to Take if Infant in Respiratory Distress?

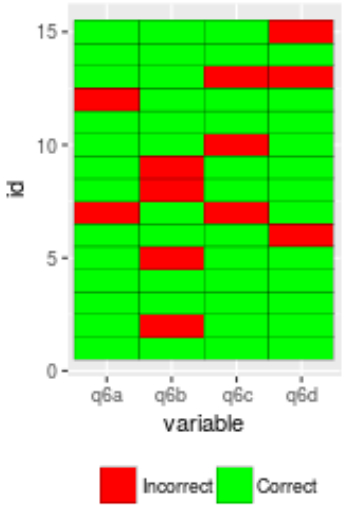
Question five asked which option was the first to be weaned, with four of the 15 answering incorrectly. Option B was the correct answer.



Label	Answer
a	liters
b	Fi02

Figure 8. Which Would You Wean First?

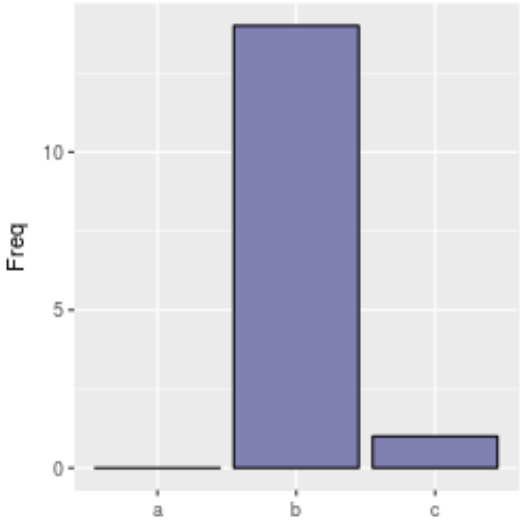
Question six asked about complications of the HHFNC and had three correct answers. Four of the 15 answered with the one wrong answer. The correct answers are A, C, and D; the incorrect answer was B.



Label	Answer	Correct?
a	Pneumothorax	Correct
b	Atelectasis	Incorrect
c	Overdistension	Correct
d	Hyperoxia and Hypocarbia	Correct

Figure 9. What are Complications from HHFNC?

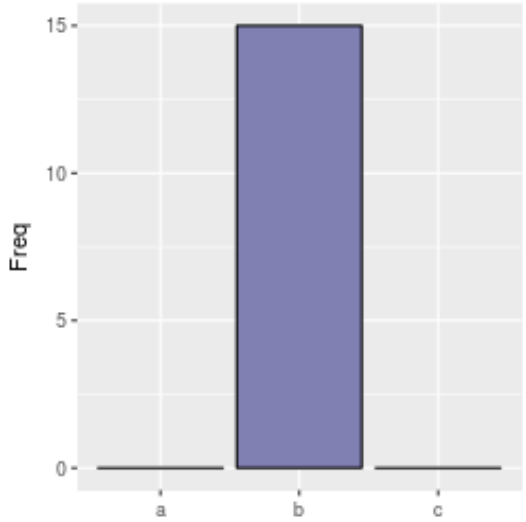
Question seven asked about the neonate being in respiratory distress and how to explain to parents about holding the neonate. One of the 15 chose the incorrect answer. The correct answer is B with incorrect answers being A and C.



Label	Answer
a	They are not allowed to hold the infant until the oxygen supplementation is completely discontinued
b	If the infant is struggling to breathe then we should inform the parents that they can touch the infant but holding them is very stressful for the infant which would make their respiration distress worse
c	Let them hold the infant, bonding is important

Figure 10. How Would You Explain When it is Ok to Hold Infant on HHFNC?

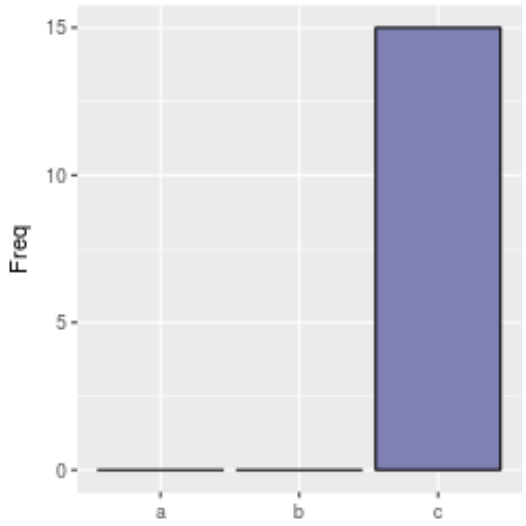
Question eight asked how to explain the benefits of the oxygen device, to which every participant got the correct answer. The correct answer is B with incorrect answers being A and C.



Label	Answer
a	Helps the infant breathe
b	the device provides pressure to keep the lungs open along with giving them a percentage of oxygen
c	All infants need it after birth to help them clear the amniotic fluid

Figure 11. How Would You Explain HHFNC to the Parents?

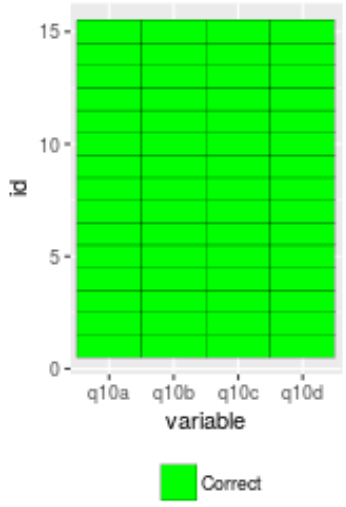
Question nine asked about what signs showed a stable respiratory status, to which all participants got the correct answer. The correct answer was C, with A and B being incorrect.



Label	Answer
a	oxygen saturations in the high 80s
b	tracheal tugging
c	oxygen saturations in the 90s

Figure 12. What are Signs of Stable Respiratory Status?

Question 10 asked what would be signs of respiratory distress, to which all participants got the correct answers. The correct answers were A, B, and D, with the incorrect answer being C.



Label	Answer	**Correct?**
a	tachypnea	Correct
b	nasal flaring	Correct
c	oxygen saturations in the 90's	Incorrect
d	subcostal retractions	Correct

Figure 13. What are Signs of Respiratory Distress?

CHAPTER FIVE

DISCUSSION

This project fulfilled the first objective of looking at the SCN nurses' baseline knowledge for the proper use of HHFNC. The results showed that the nurses were very knowledgeable on the subject, but did need further education in certain areas. The results indicated that there was a need for increased education on the management of HHFNC to decrease the incidence of deleterious effects. The strengths and weaknesses of the project were used to give an educational opportunity on HHFNC management.

The second objective was to revise the current protocol, which was found to be adequate and aligned with what was currently being recommended by the AAP. Upon looking at the current protocol, to help increase use, the staff was educated on where to find it and how to interpret it.

General Findings

In general, the survey found that there was a need for further education on management of HHFNC and how to reference the current protocol. The nurses were knowledgeable, but did have areas of learning that needed to be addressed. One of the learning needs was the difference between and correct use of FiO2 and flow. The other area discovered was the need for reviewing the reasons for use and complications of HHFNC.

Specific Findings

Questions one and two showed that the nurses either have 0–3 years as a nurse or greater than 10 years of experience being a nurse, but most nurses reported 0-3 years in the SCN. Even though some of them have been nurses for a long time, many of them are new to the rural, centrally located hospital SCN.

Question three required the nurses to choose when HHFNC should be considered for an alternative oxygen modality, but there was confusion on the way one of the options for an answer was written. This confusion was addressed during the slide presentation provided by the author after the one-hour seminar.

One-third of the nurses responding to question four answered with the wrong answer, which was “turn the flow down.” Six out of 15 didn’t answer this correctly. Question five was pertaining to the same subject of flow and FiO2 as question four, which four of 15 of them answered incorrectly. These questions showed that there is confusion between the FiO2 and flow, which indicated there were educational needs on this subject.

Four out of 15 answered with the incorrect answer (which was atelectasis) on question six. One-third of the nurses answered correctly with all three answers. This question revealed that complications of HHFNC needed further education and anatomy and physiology of the lungs would be beneficial to review.

All but one of the nurses answered question seven correctly, implying that the nurses are very appropriate and considerate of the bond between the neonate and parent.

All responding nurses got questions eight, nine, and 10 correct, which implies that they are knowledgeable on signs of respiratory distress and how to properly explain how HHFNC works for the neonate.

Nurses' Concerns about Questions

After talking with the nurses about the results of the survey, they asked for clarification on one of the questions. Question three was confusing because two of the answers were "saturating in the 90s" and "infant having apneic spells." The nurses were not aware that apneic spells suggested the use of HHFNC. The answer of "apneic spells" was an indicator that there was a knowledge deficit for the use of HHFNC and was addressed in the one-hour seminar of signs and symptoms for proposed use of HHFNC. The answer "saturating in the 90s" was confusing to some of the nurses because they thought that oxygenation at 90% was not acceptable on room air. This answer of "saturating in the 90s" was talked about and omitted from the survey results due to no specific oxygen saturation parameters on the current protocol, which was explained in a visual slide presentation led by this author.

Review of Protocol

With these survey results and review of literature, the current protocol was reviewed and it was determined that it was adequate. The same protocol was kept in place but provided an educational opportunity to address the learning needs of the SCN nurses regarding HHFNC. A one-hour seminar was presented to the SCN nurses, pediatricians, and RTs by the RT manager of Seattle Children's. In conjunction with the one-hour

seminar, a visual slide presentation led by this author was utilized with the SCN nurses who attended on the review of the results of the survey and how to find and use the current protocol.

Relation of Project to Theoretical Underpinning

According to Casey's model with neonate and pediatric populations, nurses and families must work together in the best interest of the neonate's health (Petiprin, 2016). The SCN nurses' survey results conveyed that the nurses are well-informed when it is appropriate for the parents to bond with the neonate. Likewise, they were well-informed about when it is not appropriate for parents to be holding the neonate such as when the neonate is showing signs of respiratory distress. The SCN nurses' survey results showed that they knew how to educate the parents to the purpose of the oxygen modality and how it was helping their neonate.

To foster the neonate and nurse relationship, the nurse should have proper education on how to use HHFNC. The survey revealed that there is a lack of education on the management of HHFNC; therefore, more education was needed. The lack of education conveys that the nurse may not able to manage the oxygen modality properly. This could, in turn, have negative consequences for the neonates such has pneumothorax, pulmonary interstitial emphysema, pneumomediastinum, pneumopericardium, subcutaneous emphysema, or hyperoxia and hypocapnia (Malhota et al., 2016, & Gibson & Nawab, 2015).

Dissemination

This Doctorate of Nursing Practice project was presented to the SCN nurses through a visual slide presentation led by this author at the end of the one-hour educational seminar that was arranged for the SCN nurses, pediatricians, and RTs at the rural, centrally located hospital. The one-hour seminar was on May 24, 2018, from 1200 to 1300 hours. There were six SCN nurses, five RTs, and three pediatricians who attended. Vapotherm, who sponsored the one-hour seminar, recorded the presentation so it could be listened to at any time.

Upon receiving the link, it was sent out to the SCN nurses, pediatricians, and RTs to be able to listen to if they were not able to attend. The RT manager at Seattle Children's who put on the presentation stated, if they had any questions regarding any of the research or presentation, they could contact him personally.

After the one-hour seminar, a visual slide presentation was led by this author sharing the results of the survey and how to find and use the current protocol. This slide presentation was then sent by email to all the SCN nurses to reference if they were not able to attend the seminar.

Benefits and Limitations

One benefit of the survey was that it did reveal a need for increased education on the management of HHFNC. This education need was voiced to the SCN educator who agreed that the results did represent a learning deficit and increased education was essential for providing safe care.

One limitation to this project was the small sample size. Out of 23 SCN nurses, 15 responded. This may limit generalization of these results, but this evidence-based project was performed addressing specific needs of a particular group of nurses at a rural SCN. Nurses in other rural settings may have similar needs, but future projects would need to be performed to corroborate this. Limitations for the survey would be how many nurses participated, nurses' personal experiences, current resources in the unit, and how long the person has been a nurse.

Another limitation was not surveying the pediatricians' knowledge on HHFNC. Due to time constraints of the pediatricians, they were not able to be included in the survey. While the purpose of this study was to evaluate nurses' knowledge, it would have been helpful to also determine physician knowledge. This could be a good future project to obtain this information and integrate it into the existing protocol.

One last limitation was not re-surveying the nurses after the one-hour seminar and the visual slide presentation. This post survey could have shown if the educational opportunity and review of results of the survey were helpful to the SCN nurses.

Future Considerations

Use of HHFNC still needs further investigation and research. There is not an evidence-based guideline on how to manage HHFNC that is recommended for every hospital to use. Hospitals have developed their own protocols based on different studies that have been performed and tested. Due to the lack of an evidence-based guideline, some facilities are reluctant to use HHFNC because there is not enough research on how

to properly use the oxygen modality on neonates. More studies are needed to help with the development of firm guidelines that facilities can safely and confidently use.

Additionally, there needs to be more research on small, rural hospitals that are providing this kind of care and what the best protocol would be for them compared to one used for a larger facility with more resources. Wallen (2015) states that, in any of the sequence of the neonate deteriorating, they should be transferred to a higher level of care. With a protocol in place that could help guide these kinds of questions, it would be easier for the nurses and providers to know the next steps in care.

CHAPTER SIX

SUMMARY

In summary, a survey was composed of 10 questions formulated through review of literature and help from an NNP who had previous knowledge of HHFNC. The survey contained questions about the management of HHFNC, bonding of neonate to family members while on HHFNC, and assessment of the neonate on HHFNC. The email addresses of the SCN nurses were obtained through the SCN nurse educator for the purpose of this study. The survey was then emailed to the SCN nurses who were given three weeks to email them back anonymously through the online survey tool, SurveyMonkey.

When the three weeks were over, the results were sent to the Department of Mathematical Sciences at MSU to help analyze the data. After the analysis was received from the Department of Mathematical Sciences, the learning needs were able to be identified. During this time, the existing protocol for HHFNC in this rural, centrally located hospital was reviewed with the SCN nurse educator. It was found that their present protocol is recommended by the AAP because there is no current guideline on HHFNC for neonates.

In the course of doing the literature review, the RT manager at Seattle Children's proposed to put on a one-hour seminar to help with the learning needs that were exposed by the survey. The SCN educator and a pediatrician who works at the SCN, approved having this seminar presented. Along with the SCN nurses attending, the pediatricians

and RTs were also invited to attend to help increase the knowledge of the broader health care team. The seminar was one hour long and held at the rural, centrally located hospital. There were three pediatricians, six SCN nurses, and five RTs who attended. After the one-hour seminar, a visual slide presentation was led by the author of this project for the SCN nurses who attended to share the results of the survey, where to find the current protocol, and how to use it. This slide presentation was then emailed to all the SCN nurses if they wanted to review it.

In conclusion, the review of literature, larger facility protocols, and the results of the survey showed that there were learning deficits that needed to be addressed to help increase safety and efficacy for the use of HHFNC.

At least 10% of babies born in the United States require some form of oxygen support after birth (Cox & Raghuveer, 2011). Because of the necessity and extreme complexity of oxygen support for these neonates, protocols need to be developed and approved to provide guidance to nurses and providers. The end-goal would be improving safety and efficacy in the use of these breathing modalities, which would lead to improved outcome of care.

The literature and guidelines reviewed for this project all determine that it is important to have practices in place to properly manage neonates on supplemental oxygen support. An established guideline concerning the proper process of managing HHFNC support could help decrease complications such as patient mortality and morbidity, health outcomes, and increase consistency of care (Woolf et al., 1999).

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APPENDICES

APPENDIX A

CURRENT HEATED HIGH-FLOW NASAL CANNULA PROTOCOL

TITLE:	**NONINVASIVE RESPIRATORY SUPPORT GUIDELINES**
SECTION:	**Special Care Nursery**

APPLICABLE AREAS:		CURRENT DATE:	3/16
CONTRIBUTORS:	Special Care Nursery; Peds Chair	REPLACES:	
APPROVED BY:	CNO	REVIEWED:	

PROCEDURE: Heated, Humidified High Flow Nasal Cannula (HHHFNC)

1. Nasal prong outer diameter should occupy approximately 50% of the nares internal diameter.
2. Free egress of flow around the cannula should be assessed by respiratory therapy or nursing staff at each hands-on assessment
3. FiO2 should be initiated at the same value if the infant was on another mode of noninvasive support but 5-10% higher if the infant is being extubated
4. Initial flow rate for HFNC, determined by infant weight, is as follows or per physician order:
    a. 1 kg: 3 lpm
    b. 2 kg: 4 lpm
    c. 3 kg: 5 lpm
5. Flow rate can be increased within each weight category by a maximum of 3 lpm above the starting flow rate
    a. Increase the flow rate in 1 lpm increments if:
        i. FiO2 requirement is increased by greater than 10% above the starting FiO2
        ii. pCO2 is increased by greater than 10 mmHg above the baseline value
        iii. Increased distress or retractions are noted
        iv. Decreased lung expansion is noted on CXR
    b. Flow rate can be decreased by 0.5-1 lpm increments if **all** of the following are sustained for at least a 4 hour period
        i. FiO2 is less than 30% and oxygen saturation is within ordered parameters
        ii. pCO2 is maintained within ordered parameters
        iii. no signs of significant distress are noted
        iv. lung expansion is deemed adequate
6. Transition to standard nasal cannula or oxygen hood is recommended when the HHHFNC rate was weaned to less than 2 lpm and the infant is stable based on the above criteria, including FiO2 of less than 30%.

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- *Yoder BA, Stoddard RA, Li M, King J, Dimberger DR, Abbasi S. Heated, humidified high-flow nasal cannula versus nasal CPAP for respiratory support in neonates. Pediatrics 2013; 131:e1482–e1490.*

APPENDIX B

EVIDENCE-BASE TABLE

Author/Year	Study Objectives	Level/Design/ Subjects	Intervention and Outcome Measures	Key quotes and other pertinent information	Results	Study Limitations	Implications
Mosca, F. et al, 2012	To see if using HFNC is as effective and safe as CPAP	*Subjects*: Neonates *Level*: VII *Design*: initial question and look into the science	*Intervention:* Looking into the different oral and nasopharyngeal pressures produced by nCPAP and HFNC *Outcome:* HFNC is an option for treatment after extubation and alternative to nCPAP. Measures still need to be tested in higher tests	*Key Quotes:* "HFNC should not be regarded as a form of CPAP but a distinct respiratory support modality."	*Results:* Need more information and studies on pressures created by the treatment modalities	- just a review of literature needs to implement the intervention	- using HFNC is effective in helping out an infant with increased respiratory effort
Chen, P. et al, 2014	What respiratory treatment modalities i.e. ventilator, pressure, volume treatments work best when treating ARDS in premature	*Subjects:* Premature and Extremely premature neonates with ARDS *Level:* III *Design:* Case control study	*Intervention:* distinction of ARDS and specific oxygen requirements and use of FiO2 *Outcome:* identifying ARDS is essential and using a treatment modality is optimal for respirations,	*Key Quotes:* "It is clear that respiratory support is lifesaving, but there is a lack of good evidence to choose one mode of support over	*Results:* There needs to be more support to decide on one specific treatment for ARDS in neonates	- needs more information on levels of oxygen and pressures to recommend a specific respiratory support modality	- recognize ARDS in premature infant - using a respiratory support modality right away can decrease adverse effects of

	neonates		lower FiO2 is better for premature neonates	another."			premature lungs
Abdel-Hady, H. et al, 2010	Determine a better approach for weaning neonates from nCPAP with or without NC	*Subjects:* Preterm neonates clinically stable on nCPAP *Design:* RCT *Level:* II	*Intervention:* trialing preterm neonates on room air and weaning the pressure *Outcome:* Weaning of oxygen support is in association with longer exposure to oxygen and respiratory support	*Key Quotes:* "It is rather puzzling in the current era of evidence-based medicine to find a wide spread use of NC and the introduction of HFNC in the absence of studies that assess its association with morbities."	*Results:* There was no difference in weaning from CPAP to room air and CPAP to NC to room air.	- didn't measure the amount of pressure delivered by the NC as opposed to the CPAP	- weaning from CPAP to NC is not necessary to get to room air.
Tang, J. et al, 2015	Weaning preterm neonates from CPAP by using HFNC gradually or abruptly	*Subjects:* n=60 preterm neonates *Design:* RCT *Level:* II	*Intervention:* 4 groups established to see if weaning from nCPAP to HFNC was necessary *Outcome:* Use of HFNC was not significant to reduce time of	*Key Quotes:* "Further research is required to further define the role of HFNC for primary respiratory support."	*Results:* Weaning to HFNC did not decrease LOS or days to full suck, but abrupt end to nCPAP would make parents drop out of	-had multiple families drop out of study because felt like babies were "failing at weaning" of oxygen	- weaning from nCPAP to HFNC does not reduce LOS or days to full suck feeds.

			respiratory support to full suck feeds		study.		
Rocha, G. et al, 2008	To survey neonatal supportive respiratory practices	*Subjects:* 31 Portuguese NICU's *Design:* Randomized Questionnaire *Level:* II	*Intervention:* Questionnaire given to 31 NICU's on what kind of respiratory support used *Outcome:* 94% response rate on different uses, surfactant, monitoring and CLD measured	*Key Quotes:* "Our study showed that nCPAP is preferred to be used in extremely low birth weight neonates with respiratory capability."	*Results:* The use of early nCPAP is to be encouraged in use to volume assisted ventilation.	- Just NICU's done in Portugal and what they use for respiratory care	- use of nCPAP early can help reduce the use of ventilators
Farley, R.C. et al, 2015	Determine risks and benefits of discontinuation of HFNC in preterm neonates	*Subjects:* RCT's and quasi-RCT's that used random groups of neonates that weaned from HFNC *Design:* Cochrane Review *Level:* I	*Intervention:* Finding studies that weaned neonates off HFNC *Outcome:* Not enough studies done to make an overall conclusion on a best weaning practice	*Key Quotes:* "The best strategy for weaning, withdrawal from HFNC is still unclear."	*Results:* No eligible studies found to look at best strategy for weaning or withdrawal from HFNC.	- No eligible studies found	- still needs to be research into weaning from HFNC
Spence, K.L. et al, 2007	Measure IPP generated by	*Subjects:* 14 neonates	*Intervention:* Studying IPP	*Key Quotes:* "Variability in	*Results:* HFNC has good IPP	- Limited duration of	- Use of HFNC can

	HFNC	*Design:* Study of 14 neonates on HFNC *Level:* III	monitoring of neonates on 1,2,3,4 L with 51min(-1) *Outcome:* HFNC generates well tolerated and assistive pressures when used >3L	IPP with HFNC brings about the idea of having an inline manometer with a pop off mechanism."	which can be a viable option for CPAP	monitoring	give enough pressure to use as CPAP with flows at >3L
De Paoli, A.G. et al, 2007	Effective pressures and interface of CPAP used on neonates	*Subjects:* Randomized and Quasi-Randomized comparing techniques of pressure delivered by nCPAP *Design:* Review of studies *Level:* I	*Intervention:* Looking at different studies to compare pressures of nCPAP with different techniques *Outcome:* short binasal prong device best used an better outcomes with fewer reintubations	*Key Quotes:* "Short binasal prong devices for nCPAP are more effective than single prong devices."	*Results:* short binasal prong devices more effective than single prong	- no studies looking at primary outcomes of different nCPAP systems evaluated	- Use of short binasal prongs more effective in ventilating neonates
Wilkinson, D. et al, 2016	Compare safety and efficacy of HFNC to other noninvasive respiratory forms	*Subjects:* 15 Randomized and Quasi-randomized control studies *Design:* Review of studies	*Intervention:* Use of HFNC compared to other noninvasive respiratory support. *Outcome:* Most effective use of HFNC is post	*Key Quotes:* "HFNC use resulted in longer duration of respiratory support but didn't effect outcomes."	*Results:* HFNC has similar rates of efficacy as other forms of noninvasive respiratory support	-Further studies need to be done on looking at using HFNC on neonates when not needing invasive support	- use of HFNC has the same efficacy as using CPAP for reducing rates of death, CLD, and

		Level: I	extubation				treatment failure
Heiring, C. et al, 2015	See if replacing nCPAP with low flow oxygen effects lung function	*Subjects:*52 preterm neonates postnatal days 4 to 7 *Design:* Cohort study *Level:* III	*Intervention:* switching neonates to low flow oxygen at 28 days of life from nCPAP *Outcome:* No differences in groups having longer LOS, weight at discharge or weight gain	*Key Quotes:* "Replacing nCPAP by low flow does not seem to effect pulmonary function or weight gain by end of first week of life."	*Results:* Using low flow after first week of life from nCPAP doesn't negatively effect LOS or weight gain	- stable neonates and blinding was not possible, 52 patients out of 100 randomly chosen	- using low flow when possible could make it easier on parent infant interaction and reduce cost
Greenough, A. & Sharma, A., 2007	Review of new implications of use of alternative respiratory therapies	*Subjects:* Studies from year 2000 and forward *Design:* meta-analysis of randomized trials *Level:* I	*Intervention:* Analyzing different respiratory methods and implications of use *Outcomes:* 5 different respiratory therapies with benefits and costs weighed	*Key Quotes:* "Randomized trials have failed to confirm the advantages of nCPAP, but few studies have been done."	*Results:* There are multiple benefits and costs to different kinds of respiratory therapies which should be based on disease process	- not one certain recommendation chosen. Few studies done on certain therapies	- chose what kind of respiratory therapy based on disease process will have better outcomes
De Jongh, B.E. et al, 2014	Compare WOB with CPAP and HFNC	*Subjects:* 20 neonates 28-40 wks gestation *Design:* Cohort Study	*Intervention:* WOB analyzed with CPAP and HFNC patients *Outcomes:* WOB increased with	*Key Quotes:* "Neonates with ongoing mild to moderate respiratory	*Results:* Both had increased WOB but different breathing patterns	- difficulty to enroll patients on baseline HFNC	- use of CPAP or HFNC has increased WOB and the infant breathes in a

		Level: III	both respiratory modalities, both higher than normal values	insufficiency may be engaging in breathing patterns to aide in balancing energy expenditure and gas exchange."	noticed to help with gas exchange and energy expenditure.		different pattern
O'Donnell, S.M. et al, 2010	To see if low flow with room air aides in weaning from nCPAP	*Subjects:*78 neonates *Design:* Cohort Study *Level:* III	*Intervention:* Neonates on CPAP for 24 hours weaned to room air or low flow *Outcome:* 16 neonates failed room air trial. No significant difference in vital signs.	*Key Quotes:* "Patients who failed at weaning generally had lower birth weight and gestational age."	*Results:* Patients may already be stabilized on low flow pressure while weaning from high flow and not need low flow	- not completely blinded study - hypothesis that low flow can produce efficient pressure	- there no benefit from weaning an infant from high flow to low flow oxygen
Amatya, S. et al, 2015	To see what weight, age, and correct method nCPAP should be weaned	*Subjects:* premature neonates *Design:* Systematic Review *Level: I*	*Intervention:* Using keywords, RCT's, and cross references a review done to find studies on weaning from nCPAP about method and age. *Outcome:* 7	*Key Quotes:* "This information may be useful for developing guidelines for the preterm infant."	*Results:* ideal age 32-33 wks and no one method is better than the other.	- few studies testing weaning from nCPAP - not able to do it blind - some studies used caffeine	- can start weaning oxygen at 32-33 wks old and weaning to room air predicts a shorter time on oxygen

			studies found that had correct ages and three different types of weaning mechanisms				
Sasi, A. & Malhotra, A., 2014	To determine effects of HFNC on respiratory outcomes when weaning from CPAP	*Subjects:* 1286 neonates *Design:* Cohort study *Level:* III	*Intervention:* In group 1 CPAP used for CLD and group 2 HFNC also. *Outcome:* Group 2, 6% reduced use of CPAP due to HFNC, no change in home oxygen therapy noted, HFNC no effect on home oxygen or CLD	*Key Quotes:* "HFNC is either as efficacious or non-inferior to nCPAP when used for post extubation care in preterm neonates."	*Results:* HFNC has no significant difference on RDS	- few studies done on weaning HFNC	- using HFNC as opposed the nCPAP works in the same manner in neonates of preterm neonates with CLD
Yoder et al., 2013	To determine if HHFNC is comparable to CPAP with efficacy in 28-42 week gestation neonates	*Subjects: 432 neonates Design: Randomized Study Design: Randomized Study Level: II*	*Intervention:* One group started on CPAP immediately after post extubation or as soon as respiratory distress noted. Second group started on HHFNC immediately post extubation or as soon respiratory distress noted. *Outcome:* Both groups had equal	*Key Quotes:* "HHFNC appears to have similar efficacy to CPAP when applied immediately"	*Results:* HHFNC has similar efficacy to CPAP if applied immediately	-Most neonates had RDS for a diagnosis, so this efficacy can't be correlated to other disease processes -Gestation of 28-42 weeks, didn't use younger due to evidence of not being safe	-HHFNC has the same efficacy as CPAP when an infant has RDS, is 28 weeks or greater gestation, and applied immediately

			days of supplemental oxygen, length of stay, and bronchopulmonary dysplasia				
Malynk et al., 2014	To find specific competencies in RN's and APN's for implementing EBP	*Subjects: 80 RN's and APN's* *Design: Uncontrolled cohort study* *Level: IIII*	*Intervention:* Delphi survey sent to 315 mentors, 80 responded regarding competencies for APN's and RN's in EBP *Outcome:* 13 competencies for RN's and 11 competencies for APN's	*Key Quotes:* " EBP is a life-long problem solving approach to the delivery of healthcare that integrates the best evidence from well designed studies."	*Results:* 11 competencies for APN's found and 13 competencies for RN's found	- Only surveyed people who took EBP mentor classes	- That the use of people in the work area that understand EBP can help others learn how EBP works and why it is beneficial
Lunden et al, 2017	To identify the factors that are facilitating or inhibiting nurses increase of knowledge management	*Subjects: 18 articles on knowledge management in english* *Design: Systemic Review* *Level: I*	*Intervention:* Two researchers went through 4 databases to find articles and studies on knowledge management for nurses on EBP. *Outcome:* Found that two main things affect nursing knowledge management	*Key Quotes:* "Competency means more than having skills or qualifications required by a task. It also comprises attitudes, motivation, insight, interpretation	*Results:* Found that the most influencing factors on facilitating knowledge management was organizational structure and nursing leadership. Inhibiting	- Only searched 4 databases - Had two researchers mainly searching for articles and studies	- an organizations culture and structure can influence nursing in a negative or positive way. If there is strong nursing leadership that is

			which are organizational structure and nursing leadership.	ability, receptiveness, maturity and self-assessment."	factors were organizational culture and management of human resources.		promoting EBP then the nurses can be more encouraged to learn. The organization and leadership need to work together to get an EBP movement working.
Flodgren et al., 2014	To see if the use of a opinion leader would help disseminate EBP knowledge.	*Subjects: 15 studies on opinion leaders* *Design: Systemic review* *Level: I*	*Intervention:* Two researchers used databases to look up articles that had their inclusion and exclusion criteria for using opinion leaders to help disseminate EBP knowledge. *Outcome:* Found that there were better results if an opinion leader and another intervention were done.	*Key Quotes:* " Clinical practice is not always evidence based and, therefore, may not optimize patient outcomes."	*Results:* With the studies they found that if an opinion leader and a second intervention are done it is more successful than just using an opinion leader.	- Inclusion criteria was set could have been larger to get more studies - Knowing the effect of the studies was biased based on the authors - some studies had more than one intervention or didn't have a control group to compare too.	- Overall they found that opinion leaders do have a positive effect on increasing EBP knowledge, but if another intervention is done with the opinion leader then it is more effective at

							increasing EBP knowledge.
Miller, T.L., 2012	Written article on the use of HFNC in neonates	*Subjects: review of published research Design: expert opinion Level: VI*	*Intervention:* Explaining how HFNC works, when compared to CPAP. HFNC tries to replace the reservoir of gas with oxygenated gas along with trying get rid of dead space. CPAP provides pressure to open alveoli to help exchange with gas. *Outcome:* recommended that HFNC prongs be less than 50% the size if the nares to allow removal of the exchange of gases. The recommended usage would be 3-8 L for neonates.	*Key Quotes:* "The act of ventilation refers to the circulation of air so as to replace stale or noxious are with fresh air."	*Results:* Recommended the use of HFNC in neonates to be used at 3-8L and nasal prongs should be less than 50% of diameter of nares.	- Study was supported by Vapotherm which is a supplier of HFNC -studies that were cited were still being published	- gave guidelines on how to use HFNC on neonates

Key	
nCPAP	Nasal Continuous Positive Airway Pressure
CPAP	Continuous Positive Airway Pressure
HFNC	High Flow Nasal Cannula
NC	Nasal Cannula
ARDS	Acute Respiratory Distress Syndrome
RCT	Randomized Control Trial
LOS	Length of Stay
NICU	Neonatal Intensive Care Unit
CLD	Chronic Lung Disease
IPP	Intrapharyngeal Pressure
WOB	Work of breathing
RDS	Respiratory Distress Syndrome

APPENDIX C

SURVEY TO SPECIAL-CARE-NURSERY NURSES

Management of Heated High Flow Nasal Cannula on Preterm and Term Neonates

Management of Heated High Flow Nasal Cannula

I am a doctoral student at Montana State University. As part of my final project, I am investigating the management of heated high flow nasal cannula (HHFNC) on neonates from 32-40 weeks. As a nurse in the nursery at Bozeman Health, I am requesting you complete the following survey. It should only take about 10-15 minutes to answer the 10 questions. The results from this survey will be used to help modify the current protocol for HHFNC. This survey is non-invasive and no personal information is included. You will remain completely anonymous, may cease participation in the survey at any time, and have the right to refuse to take the survey. By completion of this survey you are consenting for your answers to be used for this doctoral project. If you have any questions please contact me at: nbelling@yahoo.com. Thank you and I appreciate your participation.

1. How long have you been a nurse? w 0

- 0-3 years
- 4-7 years
- 8-10 years
- >10 years

2. How long have you worked in a special care nursery? w 0

- 0-3 years
- 4-6 years
- 7-10 years
- >10 years

3. When is it appropriate to consider using HHFNC on an infant? Choose all that apply w 0

- [ ] Low flow oxygen is not providing enough support
- [ ] Infant is having apneic spells
- [ ] Infant is saturating 90%
- [ ] Infant is just extubated

4. If the infant's respiratory distress is not stabilized, who would you consult first or what would you do first? Choose all that apply. w 0

- [ ] change neonates position
- [ ] notify the physician
- [ ] turn FiO2 up
- [ ] turn flow up

5. In general, what is recommended to be weaned first on HHFNC? w 0

- ○ liters
- ○ FiO2

6. Which of the following are complications of HHFNC. Choose all that apply. w 0

- [ ] Pneumothorax
- [ ] Atelectasis
- [ ] Overdistension
- [ ] Hyperoxia and Hypocarbia

7. If the infant is demonstrating signs of respiratory distress, which of the following statements would be best to say to the parents about holding the infant? w 0

- ○ They are not allowed to hold the infant until the oxygen supplementation is completely discontinued
- ○ If the infant is struggling to breath then we should inform the parents that they can touch the infant but holding them is very stressful for the infant which would make their respiratory distress worse.
- ○ Let them hold the infant, bonding is important.

8. When talking with parents about HHFNC, how would you explain the benefits of the machine? Choose the best answer. w 0

- helps the infant breathe
- the device provides pressure to keep the lungs open along with giving them a percentage of oxygen
- all neonates need it after birth to help them clear the amniotic fluid

9. What are signs that the infant has a stable respiratory status? w 0

- oxygen saturations in the high 80's
- tracheal tugging
- oxygen saturations in the 90's

10. If the infant is demonstrating respiratory distress, what signs and symptoms would the infant display? Choose all that apply. w 0

- [ ] tachypnea
- [ ] nasal flaring
- [ ] oxygen saturations in the 90's
- [ ] subcostal retractions

Done

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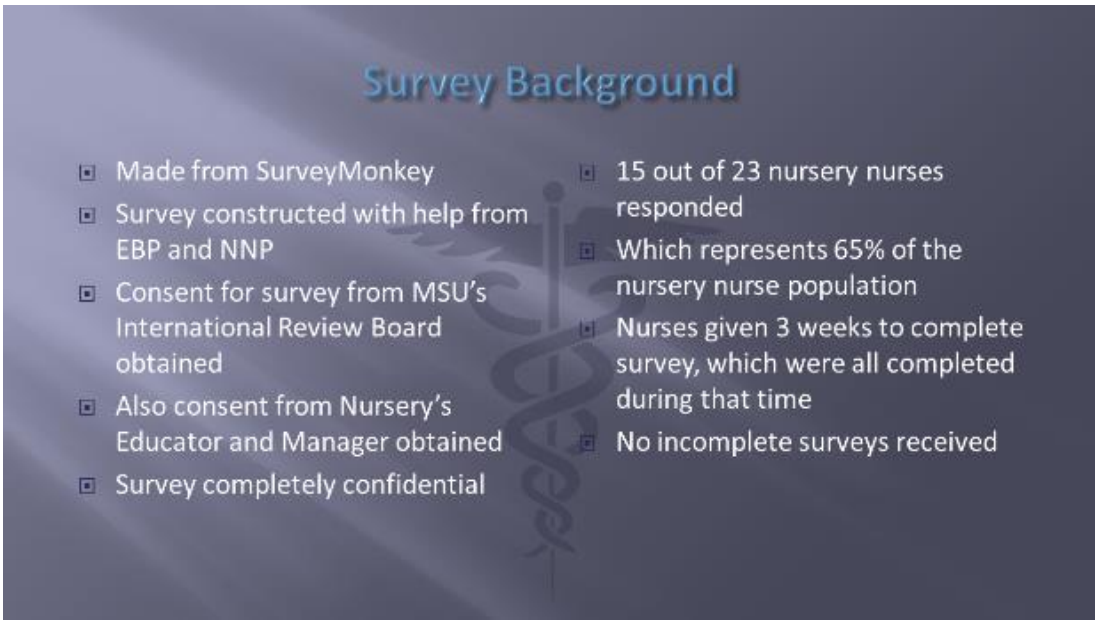
APPENDIX D

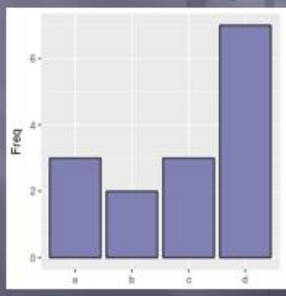
VISUAL SLIDE PRESENTATION


SURVEY RESULTS FOR HHFNC
By Nicole Belling RN, S-DNP


Survey Background
Made from SurveyMonkey
Survey constructed with help from EBP and NNP
Consent for survey from MSU's International Review Board obtained
Also consent from Nursery's Educator and Manager obtained
Survey completely confidential
15 out of 23 nursery nurses responded
Which represents 65% of the nursery nurse population
Nurses given 3 weeks to complete survey, which were all completed during that time
No incomplete surveys received

Question 1

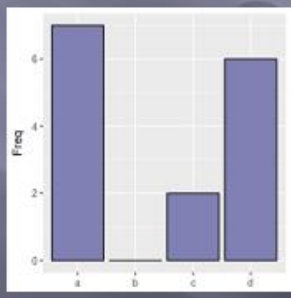
- How long have you been a nurse?
  - Greater than 10 yrs being the greatest response, 0-3 yrs and 8-10 yrs tieing with equal reponses, and 4-7 yrs being the least amount of time



Label	Answer
a	0-3 years
b	4-7 years
c	8-10 years
d	>10 years

Question 2

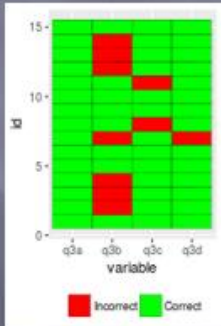
- How long have you worked in the current nursery?
  - Most prevalent was 0-3 years and greater than 10 years. No response for 4-7 years



Label	Answer
a	0-3 years
b	4-7 years
c	8-10 years
d	>10 years

Question 3

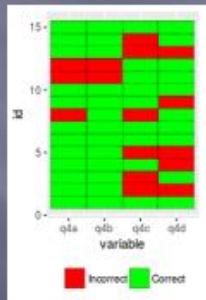
- When is it appropriate to consider using HHFNC?
  - 2 out of 15 answered with the incorrect option which was option C



Label	Answer	Correct?
a	Low flow oxygen is not providing enough support	Correct
b	Infant is having apneic spells	Correct
c	Infant is saturating 90%	Incorrect
d	Infant is just extubated	Correct

Question 4

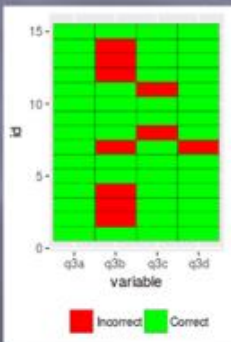
- What would be appropriate actions to take if infant in respiratory distress?
  - 5 out of 15 chose the wrong answer which was option D



Label	Answer	Correct?
a	Change infants position	Correct
b	Notify the physician	Correct
c	Turn FI02 up	Correct
d	turn flow down	Incorrect

Question 3

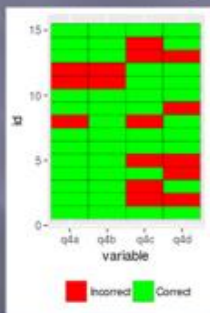
- When is it appropriate to consider using HHFNC?
  - 2 out of 15 answered with the incorrect option which was option C



Label	Answer	Correct?
a	Low flow oxygen is not providing enough support	Correct
b	Infant is having apneic spells	Correct
c	Infant is saturating 90%	Incorrect
d	Infant is just extubated	Correct

Question 4

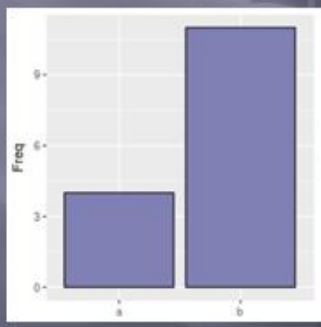
- What would be appropriate actions to take if infant in respiratory distress?
  - 5 out of 15 chose the wrong answer which was option D



Label	Answer	Correct?
a	Change infants position	Correct
b	Notify the physician	Correct
c	Turn FI02 up	Correct
d	turn flow down	Incorrect

Question 5

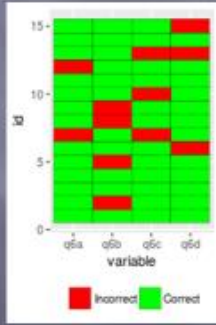
- Which would you wean first?
  - 4 out of 15 answered incorrectly with incorrect answer being A



Label	Answer
a	liters
b	FI02

Question 6

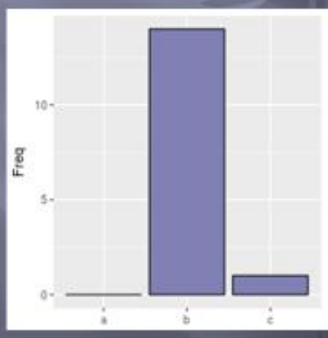
- What are complications from HHFNC?
  - 4 out of 15 answered with the incorrect answer which was B



Label	Answer	Correct?
a	Pneumothorax	Correct
b	Atelectasis	Incorrect
c	Overdistension	Correct
d	Hyperoxia and Hypocarbia	Correct

Question 7

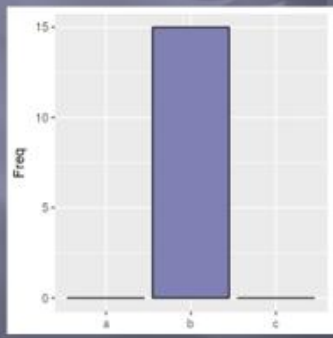
- How would you explain when it is ok to hold infant on HHFNC?
  - 1 out of 15 answered incorrectly which the incorrect answers were A and C



Label	Answer
a	They are not allowed to hold the infant until the oxygen supplementation is completely discontinued
b	If the infant is struggling to breathe then we should inform the parents that they can touch the infant but holding them is very stressful for the infant which would make their respiration distress worse
c	Let them hold the infant, bonding is important

Question 8

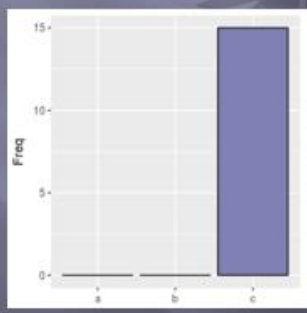
- How would you explain HHFNC to the parents?
  - 0 out of 15 answered incorrectly with A and C being incorrect



Label	Answer
a	Helps the infant breathe
b	the device provides pressure to keep the lungs open along with giving them a percentage of oxygen
c	All infants need it after birth to help them clear the amniotic fluid

Question 9

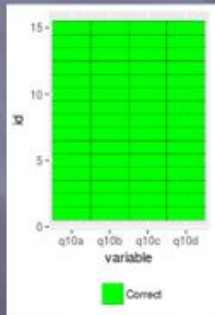
- What are signs of stable respiratory status?
  - 0 out of 15 chose incorrectly with A and C being incorrect answers



Label	Answer
a	oxygen saturations in the high 80s
b	tracheal tugging
c	oxygen saturations in the 90s

Question 10

- What are signs of respiratory distress?
  - 0 out of 15 chose incorrectly with C being the incorrect answer



Label	Answer	Correct?
a	tachypnea	Correct
b	nasal flaring	Correct
c	oxygen saturations in the 90's	Incorrect
d	subcostal retractions	Correct

Current Protocol

- Go to sharepoint website
  - Go to policies and procedures link at top
    - Under that go to departmental and look for special care nursery
      - Protocol called noninvasive respiratory support guidelines

Great Job Ladies!!