Oxygen Use in the Delivery Room and the Outcome of Bronchopulmonary Dysplasia: A Retrospective Review

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OXYGEN USE IN THE DELIVERY ROOM AND THE OUTCOME OF BRONCHOPULMONARY DYSPLASIA: A RETROSPECTIVE REVIEW

By

Blair Wagner

Paper submitted in partial fulfillment of the requirements for the degree of

Doctor of Nursing Practice

University of Louisville
School of Nursing

July 1, 2019

Signature DNP Project Chair

Signature DNP Project Committee Member

Signature Program Director

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Date

Date

Date

Date
Acknowledgements

I would like to thank Dr. Sharon Barton who has been my faculty advisor and committee chair. You have guided and mentored me to complete the Doctor of Nursing project and I have felt so encouraged by your continued support and advice. I would also like to thank Dr. Vicki Hines-Martin as a committee member and Dr. Leann Baker and Kim Knott for their time encouraging and mentoring me. I have grown not only as a provider but a woman and I am eternally grateful for all of the guidance and knowledge I have obtained from you all. To all of the University of Louisville School of Nursing faculty, thank you for the many challenges, and opportunities that have led to my personal and professional growth.
Dedication

I would like to dedicate my DNP Final Project to my husband Jed, and daughter, Wren. Words cannot describe how blessed I am to have such a supportive, loving, and encouraging family. From our wedding to having our first child, Jed you have been a Godsend and I would not be where I am today without your constant, never wavered love and guidance. Wren, you know more neonatal pathophysiology than any one year old should; thank you for giving me the courage and confidence to finish this program. Thank you to my dad and mom and the rest of my family for always believing in me and helping me to reach this goal, this is for you!
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Abstract

Recent evidence confirms the first 10 minutes after birth are extremely important for the short and long-term outcomes of premature infants, specifically for the risk of developing bronchopulmonary dysplasia (BPD). Neonates who are resuscitated with 100% oxygen concentration in the delivery room during the first 10 minutes after birth have a 35% chance to develop BPD (Vento, 2009). Neonates who are resuscitated with lower oxygen levels in the first 10 minutes of life have a 15% chance of developing BPD. BPD is diagnosed when a neonate requires oxygen at ≥28 postnatal days or at 36 weeks corrected gestational age, along with clinical symptoms of severe respiratory disease, such as increased work of breath, tachypnea, opacities throughout bilateral lung fields via chest radiograph, and necessary supplemental oxygen (Wambach & Hamvas, 2015). BPD is the leading cause of morbidity and mortality during the first year of life in the developed world (Zysman-Colman et al., 2013). Neonates with BPD have shorter life spans due to airway obstruction, reactive airways, and emphysema. Neonates with BPD have a 50% increased chance of rehospitalization during the first year of life, as well as significant cardiovascular adverse effects and subsequent neurodevelopment delays (Kair, Leonard, & Anderson, 2012). This project was implemented in the University of Louisville (ULH) Neonatal Intensive Care Unit (NICU) with data gathered from the Vermont Oxford Network (VON) database on neonates born between 24-32 weeks gestation at ULH to identify if highly concentrated oxygen use during initial resuscitation occurred at a higher rate in infants who subsequently had a diagnosis of bronchopulmonary dysplasia (BPD). While the literature contains evidence that high versus low oxygen concentration, during the first 10 minutes of life leads to outcomes of BPD, this review was undertaken to determine the current initial resuscitation practice in the ULH NICU and neonatal outcomes of BPD.
Keywords: oxygen saturation, bronchopulmonary dysplasia, preterm infant, delivery room resuscitation, limited versus high oxygen strategy, initial fraction of oxygen (FiO2), oxidative stress
Oxygen Use in the Delivery Room and the Outcome of Bronchopulmonary Dysplasia: A Retrospective Review

Bronchopulmonary dysplasia (BPD) is the leading cause of morbidity and mortality in neonates during the first month of life in the developed world (Zysman-Coleman et al., 2013). Despite advances in neonatal care, BPD remains an important complication of preterm birth and often results in mortality and short and long-term morbidities. BPD is a chronic lung disease often associated with neonates who are born preterm, have low birth weight, and require mechanical ventilation and oxygen therapy. BPD can be considered a disorder of lung development, due to the disruption in the septation of the alveoli and alveolar hypoplasia leading to fewer larger alveoli resulting in a decrease in surface area available for gas exchange (Zysman-Coleman et al., 2013). The diagnosis of BPD is made when supplemental oxygen is needed at \( \geq 28 \) days after birth or at 36 weeks corrected gestational age. The pathophysiology and presentation of BPD have changed in the past decade due to changes in clinical practice, such as lung protective ventilation strategies, antenatal glucocorticosteroids, and surfactant therapy usage. Despite these preventive measures, BPD still exists. Long-term morbidities of neonates with BPD include neurodevelopmental delays and cardiovascular sequelae (Zysman-Colman et al., 2013).

**Mechanism of Lung Damage in BPD**

The use of excessive oxygen produces harm to the infant due to oxidative stress. Excessive oxygen in this study is defined as the use of endotracheal tube intubation, the use of persistent pulmonary ventilation, or continuous positive airway pressure. Oxidative stress in the neonate is characterized by the biomarkers of oxidized glutathione or antioxidant enzyme activity, which is significantly increased in neonates receiving excess oxygen in the delivery
room. Newborn infants resuscitated with pure oxygen (100% O2) have higher oxidative stress after resuscitation compared to newborns recovered with room air (21% O2) (Vento, 2015). Increased oxygen consumption increases the activation of leukocytes and endothelial cells, which increases the formation of reactive oxygen species and reactive nitrogen species (Vento, 2015). This creates oxidative stressors on the body, which leads to ischemic lung tissue and the subsequent development of BPD (Vento, 2015).

**Final Problem Statement**

Although research confirms that the outcome of high oxygen concentrations during neonatal resuscitation is associated with outcomes of bronchopulmonary dysplasia little is known about current practices and outcomes at the ULH NICU.

**Purpose of Project**

The purpose of this project was to determine the amount of FiO2 premature infants receive in the ULH NICU and to determine whether there was an increased risk of developing BPD because of non-evidence based practices. Current evidence exists that reducing FiO2 concentrations at birth and during the neonatal period can reduce the occurrence and harm of BPD. This project was warranted to examine the concentration of O2 delivery to infants in the ULH NICU and those who subsequently develop BPD. The practice site for the DNP project identified a goal to reduce bronchopulmonary dysplasia in the ULH NICU population. This project provided evidence-based analyses of current practices, and provided value to the ULH NICU.

**Clinical Question**

Are infants in the NICU who are resuscitated with high concentration of Fi02 during birth likely to be diagnosed with BPD vs. Infants resuscitated with low levels of Fi02?
Review of Literature

The current research surrounding excessive oxygen use in the delivery room and the outcome of BPD is broken down into the subcategories of BPD related to O2 during neonatal delivery, high vs. low FiO2 groups, and morbidity in BPD. An evidence summary is warranted to understand and defend this project as it suggests high oxygen usage during birth resuscitation, increases the likelihood of neonates developing BPD due to oxidative stressors and subsequent lung damage.

High vs. Low FiO2 Groups

A study by Koh et al. (2012) assessed the use of pure oxygen (100% O2) in neonatal resuscitation versus blended oxygen concentrations. This study provided the first data of usage of blended oxygen during neonatal resuscitation in non-Western and low-resourced countries. Koh et al. (2012) determined when blended oxygen was used compared to pure oxygen, a decrease of oxygen toxicity was found particularly in hypoxic neonates. The use of pure oxygen can increase rates of chronic lung disease resulting in significant mortality in these non-resourced countries (Koh, Yeo, Wright, Lui, Saugstad, Tarnow-Mordi...Oei, 2012).

Wilson et al. (2017) conducted a randomized controlled trial recruiting a total of 45 preterm neonates and recording of the amount of oxygen received in the delivery room. Seventeen neonates born between 28-37 weeks gestation were administered 21%-30% oxygen during birth resuscitation. A group of 28 preterm neonates born between 28-37 weeks gestation received 70-90% O2 during birth resuscitation. The results of this study supported the recommendation that FIO2 should be administered between 21-30% FiO2 based on the absence of oxidative stress in the low oxygen group and subsequent chronic lung disease found in the group of neonates who received 70-90% oxygen.
A prospective randomized trial by Escrig et al., (2008) on 42 neonates <28 weeks gestational age, was conducted based on the maximum amount of oxygen used in the delivery room. At delivery, FiO2 was applied at 30% oxygen on 19 neonates compared to 90% FiO2 on 23 neonates. The target Saturation of Peripheral Oxygen (SpO2) was 85% at 10 minutes of life for all 42 neonates. All neonates received FiO2 reduced by 10% over the first 10 minutes of life to reach a target SpO2 level. The research team measured the amount of time it took for each neonate to achieve targeted optimal oxygen saturation during the first 10 minutes of life. It was determined neonates who received a high amount of FiO2 during resuscitation took longer to achieve and maintain the targeted SpO2 level in the delivery room, compared with neonates who received amounts of oxygen <60% in order to achieve target oxygen saturations (Escrig et al., 2008).

Vento et al. (2009) found similar results to those by Escrig et al. A randomized controlled trial of recruited 78 neonates between the ages of 24-28 weeks gestation, who needed O2 administered during birth resuscitation. Thirty-seven of the neonates were given 30% FiO2 during birth resuscitation and the other 41 neonates received 90% FiO2. The target SpO2 was 75% oxygen saturation at 5 minutes of life and 80% at 10 minutes of life. Adding to our knowledge about FiO2 delivery and outcomes, Vento concluded that BPD occurred more frequently with the neonates who received 90% FiO2 to reach optimal oxygen saturation at both 5 and 10 minutes of life (Vento et al., 2009).

Additional precursors to BPD, such as increased oxygen consumption during delivery room resuscitation, ventilator duration, and surfactant administration, were reported in a randomized controlled trial by Kapadia et al., (2013). Oxygen resuscitation after birth was recorded on 88 neonates between 24-34 weeks gestation. Infants were divided evenly into two
groups. These groups were assessed during immediate oxygen administration. 44 neonates received 21% O2 at delivery and 44 neonates received 100% O2. The analyses determined that oxidative stress markers were significant findings in the forty-four neonates who received 100% O2 during birth resuscitation, compared to the neonates who received 21% O2 (Kapadia et al., 2013).

A randomized trial conducted in two separate NICUs in Australia gave 60 neonates 100% O2 at delivery and 59 while the comparison neonates received 21% O2 at delivery. The research found oxidative stress, which is an indication for BPD was higher in the neonates who received 100% O2 after delivery when comparing with the group of 59 neonates who received 21% O2 (Tataranno et al., 2015).

In a randomized control trial by Oei et al (2017), records were reviewed from 768 neonates born < 32 weeks gestation. The study divided neonates into a group that received a higher concentration of FiO2 at birth and one group receiving a lower FiO2. The lower FiO2 were neonates given 30%FiO2 or less during the first 10 minutes of life and the higher FiO2 group were neonates who received greater than 60% FiO2 during resuscitation in the first 10 minutes of life. The Sp02 on 706 infants was measured at 5 minutes of life. 159 infants met the Sp02 target and 323 neonates did not meet the 80% Sp02 target at 5 minutes of life. It was determined that if the resuscitation was initiated at less than 30% FiO2 combined with an SP02 of less than 80% the neonate had less of a chance of developing BPD (Oei et al., 2017).

A meta-analysis supports the efficacy of lower levels of FiO2 at birth to decrease development of precursors to BPD. Saugstad et al., (2014) conducted a systematic meta-analysis of 10 randomized studies. These studies analyzed neonates < 32 weeks gestation receiving either high or low concentrations of O2 during delivery resuscitation. The low group included 321
neonates who received 21-30% O2 during delivery. The high group (n=356) received O2 at 60-100% during resuscitation. Clinical outcomes were observed to determine if excessive oxygen use after delivery caused oxidative stress and further morbidities for the neonate. It was determined that neonates in the study who received a high concentration of O2 during delivery resuscitation had oxidative stress and further complications including oxygen use at 28 postnatal days and continued supplemental oxygen use at 36 weeks corrected gestational age (Saugstad et al., 2014).

**Morbidity in BPD Associated With High Levels of O2 Delivered at Birth**

Bronchopulmonary dysplasia (BPD) is a condition with mortality and significant morbidity that can occur when high concentrations of FiO2 are administered during birth resuscitation (O’Donnell et al., 2007, Dawson et al., 2010, Escrig et al., 2008, Vento et al., 2009, Escrig et al., 2008, Kapadia et al., 2013, Tataranno et al., 2015, Gandhi & Finer, 2013, Koh et al., 2012). Evidence exists that reducing oxygen concentrations at birth and during the neonatal period can reduce the occurrence and harm of BPD (Oei et al., 2017, Barlena-Borneman, Ambalavanan, Tiwari, Firiffin, Halloran, & Askenzai, 2017). Vento et al., (2009) stated that all neonates in their RCT were assessed for supplemental oxygen usage at 28 postnatal days and at 36 weeks corrected gestational age; each neonate still on oxygen at 36 weeks corrected gestational age was administered excessive of >60% FiO2 during birth resuscitation (2009).

**Summary**

BPD is the leading cause of morbidity and mortality during the first month of life in the developed world (Zysman-Colman et al., 2013). Saugstad et al., in a meta-analysis determined that neonates who received recessive oxygen in the delivery room were more likely to experience
oxidative stress and thus an increased risk of developing BPD. Excessive oxygen uses can lead to inflammation, lung damage and other irreversible morbidities such as neurodevelopmental delay and increased risk for right-sided heart failure (Saugstad et al., 2014, Vento et al., 2017, Hwang & Rhan 2018). The literature reviewed outlined five key points. These include the recognition that BPD is a condition with some mortality and significant morbidity that can occur when high concentrations of O2 are administered during birth resuscitation. Current evidence exists that reducing O2 concentration at birth and during the neonatal period can reduce the occurrence and harm of BPD. A gap in the literature includes the lack of evidence on the circumstances surrounding the development of BPD in infants in the ULH NICU. The ULH NICU had identified a goal to reduce lung disorders in their NICU. Currently literature identifies that an examination of initial resuscitation may better determine the premature neonate’s likelihood of developing BPD.

**Conceptual Framework**

The conceptual framework used for this project was the Synergy Model. *See Figure 1.* The Synergy model focuses on the alignment between patient needs and nursing competencies (Hardin, 2017). The context and patient/nurse relationship is the focus of this model. The Synergy Model is used as a professional practice model in many institutions to assist in nurse education, competencies, and certifications (Hardin, 2017). The guiding framework of the Synergy Model matches knowledge, skills, and abilities of the nurses to their competencies with patient needs to promote optimal outcomes. This project proposal used the central idea that patient needs drive nursing competencies. This project outlined the competencies the nurses and respiratory therapists must meet in order to promote the best patient outcomes as they related to the development of BPD. This practice change model integrates learning, knowledge, and
experience and applies it to clinical decisions made during the course of care for patients (Hardin, 2017). The clinical decision of administering excessive amounts oxygen and mode in the delivery room on preterm infants directly increases the risk of the neonate developing BPD, therefore the nurses’ competencies and clinical decisions can directly affect the likelihood of a preterm neonate developing BPD.

**Setting and Organizational Assessment**

**Participants**

Participants in this study were comprised of neonates born between 24-32 weeks gestation in 2017 at ULH, who received oxygen resuscitation in the delivery room. The records of the included neonates were queried to determine gestational age at birth, supplemental oxygen usage and mode in the delivery room, oxygen use and mode after the initial resuscitation, oxygen use at discharge, and if BPD was diagnosed.

**Setting**

The target population included preterm infants born between the gestational ages of 24-32 weeks at the ULH, NICU. The ULH NICU is a level 3 NICU admitting all inborn neonates from 22 weeks gestation up to 40+ weeks. The inclusion criteria included neonates born between 24-32 weeks gestation requiring oxygen resuscitation in the delivery room. The exclusion criterion included neonates who died prior to 36 weeks gestation or in the delivery room or neonates born at greater than 32 weeks gestation or less than 24 weeks gestation and, lastly neonates born before January 1, 2017 or after December 31, 2017.

This project was implemented at the University of Louisville Hospital’s Neonatal Intensive Care Unit. This NICU is a 28-bed, intensive care unit for ill term infants and preterm infants from 22 weeks gestational age on. The Vermont Oxford Network (VON) database from
2017 included a description stating the ULH NICU consists of 18 intensive care beds and 10 step-down beds. This NICU admitted 306 neonates in 2017. Admitting birth weight ranged from less than 501 grams (1.6%), 501-1,000 grams (8%), 1,001 to 1,500 grams (7.8%), 1,501-2,500 grams (35%), and greater than 2,500 gram (47.7%). The ULH labor and delivery unit had a total of 1,874 deliveries in 2017. The ULH labor and delivery unit is categorized as a level 3 unit, which means they are able to provide care for all complex deliveries and have a full time in-house maternal-fetal specialist available for delivery (VON, 2017).

**Tools**

A retrospective review was conducted on 67 VON records from neonates born between 24-32 weeks gestational age at the ULH. The VON records were from neonates born from January 1, 2017 to December 31, 2017 who required oxygen supplementation during birth resuscitation. The variables gathered included gestational age at birth, if oxygen was used during initial resuscitation and if the mode was high or low. High oxygen was defined as endotracheal intubation or positive pressure ventilation. Low oxygen was defined as continuous positive pressure ventilation, high flow nasal cannula, or nasal cannula usage. Other variables gathered included oxygen usage after initial resuscitation, duration of oxygen usage, if oxygen was used during discharge, and if BPD was diagnosed prior to discharge. ET intubation and PPV are always associated with high O2 concentration and CPAP, high flow nasal cannula (HFNC), or nasal cannulas (NC) are always lower O2 concentration. During initial resuscitation neonates are intubated based on need for oxygen >75% O2, while PPV is administered due to low heart rate and need for >75% O2 administration. Low oxygen concentration is summarized as HFNC or NC due to the inability for those modes of ventilation to provide excessive oxygen administration (<75% O2).
While literature contains evidence supporting the association between high oxygen concentration during birth resuscitation and the outcome of BPD, this review will help determine the current practices and resulting neonatal outcomes in the ULH NICU. Sixty-eight charts were reviewed. The Vermont Oxford Network (VON) database was used to obtain all of the variables and data. Individual medical records were not accessed for this study. A logistic regression was conducted and assigned binary outcomes of high versus low oxygen was used in during initial resuscitation, which better predicted the amount of oxygen mode that contributed to an increased risk of developing BPD.

**Measures**

The VON is a database from nearly 1,000 NICUs around the world. The database at the University of Louisville’s NICU provided the number of preterm neonates born between 24-32 weeks gestation at ULH in 2017. The VON database was examined for each neonate with a diagnosis of BPD. From VON I obtained: gestational age at birth, supplemental oxygen during initial resuscitation, oxygen usage after initial resuscitation, duration of supplemental oxygen usage in the NICU, oxygen usage at discharge, and diagnosis of BPD prior to discharge.

**Process**

No identifiable medical records were reviewed. Data were extracted from the VON database retrospective from 67 neonates born between 24-32 weeks gestation and delivered between January 1, 2017 through December 31, 2017.

All data collected by DNP student were obtained during specific project hour visits. Data were deidentified by VON database system. All data obtained were confidentially protected. The data were stored on an encrypted and password-protected laptop.

**Consent Process**
Permission for this project was supported by ULH NICU administration, including Pauline Hayes, NICU nurse manager and Reetta Stikes, ULH NICU’s educational and research coordinator. The University of Louisville’s Institutional Review Board and University of Louisville Nurse Review Board approved this study.

**Intervention**

The gathering of data about the ULH NICU’s current practices was done through a VON database review and data analysis was performed using statistics available in the Excel program. The analysis examined the associated between oxygen use and BPD diagnosis. A chi-square was used to determine whether there was a relationship between initial oxygen resuscitation and the development of BPD. My question was to determine whether premature neonates in the ULH NICU (dependent variable) had a greater chance of developing BPD due to high oxygen administration during initial resuscitation (independent variable) compared to those neonates who received a low amount of oxygen during initial resuscitation. These findings were shared with the staff to assist in developing a future intervention to address current practices and the best evidence. This knowledge and practice changes can help to decrease the number of neonates who develop BPD.

This process evaluation project included the following stakeholders: healthcare providers, registered nurses, advanced practice nurses, and respiratory therapists. The data analysis from this project determined the current practices at the ULH NICU. An assumption is that once stakeholders understand their current practices and the mismatch with the best evidence, they can be better informed for developing priorities for future research and clinical care.

An educational lecture during a staff meeting for the ULH Women and Infants employees disseminated the project findings. The expectation is to further improve infant care at the ULH
NICU by providing recommended guidelines for delivery of oxygen administration in the delivery room setting. The educational session included handouts displaying project data, statistical information, and helpful tips on evidenced-based practices to minimize excessive oxygen in the delivery room. The goal of this project was to responsibly shape the future practices of the ULH NICU team members including RNs, APRNs, and respiratory therapists.

The chart review was the intervention used in this project to gain information about current practices at the ULH NICU. The knowledge obtained provided specific information about an infant receiving a diagnosis of BPD based on current practices of oxygen delivery during birth resuscitation in the ULH NICU.

Analysis

This project used an Excel spreadsheet to organize data collection and interpretation. The variables gathered were: gestational age at birth, initial resuscitation (yes/no), high or low oxygen administration during initial resuscitation (endotracheal tube intubation (ETT)/positive pressure ventilation (PPV)=high oxygen use and low oxygen administration included (high flow nasal cannula, nasal cannula, or no oxygen administration), oxygen use after initial resuscitation (yes/no), oxygen use at discharge (yes/no), and diagnosis of BPD (yes/no) (See Appendix A, pg. 36).

Results

The hypothesis, based on evidence in published literature was the greater the amount of oxygen administered during initial birth resuscitation; the greater likelihood the preterm infant will develop BPD. The value was to gather the data and determine if the ULH delivery staff was using best evidence or if quality improvement was needed. Based on the information gathered it was determined that although high oxygen concentration does contribute to the diagnosis of BPD
there are many other variables associated with the diagnosis.

The purpose of this project was to answer the question, “in the ULH NICU what is the practice regarding high vs. low O2 delivery during neonatal resuscitation?” The analysis of current ULH NICU practice was to determine whether infants were at an increased risk for developing BPD due to the practice of resuscitation using high concentrations of O2. Data for this study were gathered from VON database of neonates born between 24-32 weeks gestation between January 1, 2017 and December 31, 2017. All analyses reported were done using Excel.

The data from 68 neonates were gathered from the VON database. Ages ranged 24 weeks and 2 days gestation to 32 weeks and 6 days gestational age (Table 1). Each data point represented a separate patient and separate encounter. The data gathered from the VON database included gestational age (numeric), oxygen during initial resuscitation (yes/no), oxygen administration type during initial resuscitation (ventilation, CPAP, high flow nasal cannula, nasal cannula or none), oxygen after initial resuscitation (yes/no), oxygen administration type after initial resuscitation (ventilation, CPAP, NC, or none), duration of oxygen after initial resuscitation (# of days), diagnosis of BPD (yes/no), and oxygen at discharge (yes/no). The mean age was 29 weeks and 7 days. 4 neonates died before the diagnosis of BPD was made. 2 neonates died on day of life 2 and two neonates expired in the delivery room. Out of the 68 cases 9 total neonates did not receive any oxygen during delivery room resuscitation and were therefore not on any oxygen during their NICU stay.

Neonates were assessed based on their gestational age at birth and the association of development of BPD. The following tables break down the neonates in weeks of gestation at birth and amount of neonates who were given high vs. low O2 during IR and their development of BPD (Table 2). A decrease in BPD diagnosis is associated with an increase gestational age,
there is a high probability for the development with BPD the younger the gestation at birth (Table 3).

Thirty-five neonates received none to low levels of oxygen in the delivery room. A low amount of oxygen was defined as the administration of oxygen via nasal cannula (NC), high flow nasal cannula (HFNC), or no oxygen administration. High or excessive amounts of oxygen were defined as the use of an endotracheal tube (ETT) placement with ventilation, positive pressure ventilation (PPV), or continued positive airway pressure (CPAP). 33 neonates received a high amount of oxygen in the delivery room and while 35 received a low to no amount of oxygen out of a total 68 neonates born between 24-32 weeks at the ULH NICU between January 1, 2017 to December 31, 2017 (Table 4).

Analysis of the relationship between high amounts of oxygen administered in the delivery room and BPD was the initial goal of this project. 35 neonates received low/no oxygen during initial resuscitation and 16 were still diagnosed with BPD. 19 of neonates that received either HFNC, NC or no oxygen administration were not diagnosed with BPD. (Table 5). High oxygenation during initial resuscitation was then broken down to neonates who developed BPD (15 out of 33) and those who did not develop BDP even though they received high concentrations of oxygen during initial resection (18 out of 33) (Table 6). High oxygenation after initial resuscitation was also analyzed to determine if other factors such as continued ventilation or high-pressure oxygenation usage, which contributed to the diagnosis of BPD (Table 7). This highlights the need for further evaluation of how BPD develops and the need to add in associated risk factors such as mechanical ventilation time and surfactant administration after admission to the NICU.

VON displays a binary dataset that does not express the exact concentration of oxygen
administered in the delivery room. Therefore, this project was not able to perform more detailed analyses. These data were able to describe the evidence that higher concentrations of oxygen administered via endotracheal tube, positive pressure ventilation and high frequency ventilation were associated with a BPD diagnosis in BPD in 22% of premature neonates born between January 1, 2017 and December 31, 2017.

Further study of exact Fi02 concentration would be necessary to find the related oxygen usage odds ratio to bronchopulmonary dysplasia diagnosis in preterm infants at the ULH NICU. The incidence of BPD increases with a younger gestational age at birth and affects approximately 30% of preterm infants (Gomella, Cunningham, and Eyal, 2013). This project concluded 16 out of the 67 neonates born prematurity in 2017 were diagnosed with BPD. This equates to 23.8% of neonates in the ULH NICU were diagnosed with BPD when high concentration oxygen was used in the delivery room setting.

Discussion

Interpretation

This project determined that many variables contribute to the diagnosis of BPD and potentially negative long term outcomes for premature infants in the ULH NICU. The variable of excessive oxygen administered during initial resuscitation was associated with 22.8% of premature neonates developing BPD. This factor is a contributor of BPD but many other variables contribute to the final diagnosis. In this study there was no significant difference in BPD outcome in those with high versus low oxygen requirements. The data gathered from the ULH NICU’s VON database gave us a picture of current practice in O2 delivery at neonatal resuscitation. I was unable to obtain oxidative stress markers due to the project’s design.

Limitations
We did not find statistical significance regarding our hypothesis that high O2 delivery at neonatal resuscitation is associated with development of BPD. This study was limited to the binary data obtained from the VON database. Further studies using patient medical records may yield more information about specific variables in patient charts including exact oxygen administration percentage during initial resuscitation and oxidative stressors that result in the development of BPD.

Multiple Chi-square tests were selected to determine the significance level of group comparisons. None of the $X^2$ tests demonstrated significance <.05 (Table 8). The variables assessed were the correlation between high oxygen during and after initial resuscitation and the development of BPD. There is no credible evidence whether the simple variable of excessive oxygen during initial resuscitation results in BPD in premature neonates born between 24-32 weeks gestation at the ULH NICU.

This study was limited by the number of data points from the year. Only 68 neonates were born in the ULH NICU between 24-32 weeks gestation during 2017. Using a longer timeframe for VON data would yield more data points for examination. Another limitation included not including medical record information in the data collection. This tactic could have yielded more in-depth information about O2 concentrations. The study should be further evaluated in this NICU to best determine how educational processes could benefit the providers of the ULH NICU on decreasing overall diagnosis of BPD in premature infants. This project determined that although oxygen administration is a contributor of BPD, causality could not be proven. Future research should include multivariate approaches.

**Conclusion**

In order to provide new insight into the existing knowledge of excessive oxygen use
increasing the risk of developing BPD, these findings were disseminated to the staff and healthcare team during a quality improvement leadership monthly meeting on July 16, 2019. The most important and expected finding in this study is the results of premature infants who receive high oxygen and the less premature infants who receive less concentration. The most vulnerable infants need more invasive treatment, therefore exposing themselves to an increased incidence of developing BPD.

A larger dataset I needed to obtain specific information on variables associated with the development of BPD. Data should be gathered for at least 2 years and a multivariate analysis with high versus low oxygenation should be obtained. It is necessary to continue this study and gather specific information amount mechanical ventilation, if exogenous surfactant was administered, when and how many doses and if the use of high frequency ventilation or if nitric oxide was administered during the first 2 weeks of life. The immediate goal of this project was to disseminate evidenced-based information to the staff about their current practices. The future implications will potentially provide data that will inspire a quality improvement project to decrease excessive oxygen use during the first 10 minutes of life for preterm neonatal birth resuscitations. Ultimately this study hopes to reduce the incidence of bronchopulmonary dysplasia due to excessive oxygen administration in order to promote the best possible patient outcomes in the ULH NICU.
References


OXYGEN USE IN THE DELIVERY ROOM


Appendix A

The Synergy Model

Appendix A: The Synergy Model- with special considerations for this project.
## Appendix B

Excel Example Data Set Table

<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>Oxygen During Initial Resuscitation (Yes/No)</th>
<th>Type of O2 administered during IR (High/Low)</th>
<th>Oxygen after IR (Yes/No)</th>
<th>Type and Duration of oxygen after IR (High/Low)</th>
<th>Diagnosis of BPD (Yes/No)</th>
<th>Oxygen at Discharge (Yes/No)</th>
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<td></td>
</tr>
</tbody>
</table>

*Appendix B: Example EXCEL spreadsheet for documentation of extracted data.*
Table 1

*Distribution of Gestational Ages and Associated Outcome of BPD*

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean Gestational Age</th>
<th>Std.</th>
<th>Median</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Total of Gestational Age at birth</td>
<td>68.00</td>
<td>29.66</td>
<td>2.55</td>
<td>30.07</td>
<td>24.29</td>
<td>32.86</td>
</tr>
<tr>
<td>No To Low O2 During IR With BPD **</td>
<td>1.00</td>
<td>26.57</td>
<td>N/A</td>
<td>26.57</td>
<td>26.57</td>
<td>26.57</td>
</tr>
<tr>
<td>No To Low O2 During IR Without BPD</td>
<td>34.00</td>
<td>31.24</td>
<td>1.51</td>
<td>31.50</td>
<td>25.86</td>
<td>32.86</td>
</tr>
<tr>
<td>High O2 During IR With BPD</td>
<td>15.00</td>
<td>26.76</td>
<td>1.53</td>
<td>27.00</td>
<td>24.29</td>
<td>29.14</td>
</tr>
<tr>
<td>High O2 During IR Without BPD</td>
<td>18.00</td>
<td>29.24</td>
<td>2.35</td>
<td>29.57</td>
<td>25.43</td>
<td>32.86</td>
</tr>
</tbody>
</table>

** Only one subject met given criteria
Table 2

*Number of Neonates With and Without BPD Based on Gestational Age/High vs Low Oxygen During Initial Resuscitation.*

<table>
<thead>
<tr>
<th>Gestational Age at Birth In Weeks:</th>
<th>With BPD</th>
<th>Without BPD</th>
<th>With BPD</th>
<th>Without BPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>25</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>26</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>28</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>29</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>31</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>32</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>20</td>
<td>1</td>
<td>34</td>
</tr>
</tbody>
</table>

*Note. BPD- Bronchopulmonary dysplasia*
Table 3

Gestational Ages at Birth and the Association of Bronchopulmonary Dysplasia With High Oxygen Administration During Initial Resuscitation.
Table 4

*Distribution of Oxygenation During Initial Resuscitation with Total Neonates*

![Oxygenation During Initial Resuscitation Chart]

Table 5

*Distribution of Low to No Oxygenation During Initial Resuscitation and the Development of BPD vs. No Development of BPD*

![Low/No Oxygenation During Initial Resuscitation Chart]
Table 6

*Distribution of High Oxygenation During Initial Resuscitation and the Development of BPD vs. No Development of BPD*

![Diagram showing high oxygenation during initial resuscitation](image)

**Table 7**

*Distribution of High Oxygen After Initial Resuscitation and the Development of BPD*

![Diagram showing high oxygen after initial resuscitation](image)
Table 8  

Chi-Square Test Evaluating the Significance of Oxygen Use During Initial Resuscitation and After Initial Resuscitation and the Diagnosis of BPD

**Actual Values: Oxygen Usage During Initial Resuscitation**

<table>
<thead>
<tr>
<th></th>
<th>High O2 During IR</th>
<th>Low or No O2 During IR</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPD</td>
<td>48%</td>
<td>51%</td>
<td>100%</td>
</tr>
<tr>
<td>No BPD</td>
<td>48%</td>
<td>51%</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>48%</td>
<td>51%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*P Value* 0.982852

**Actual Values: Oxygen Usage After Initial Resuscitation**

<table>
<thead>
<tr>
<th></th>
<th>High O2 After IR</th>
<th>Low or No O2 After IR</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPD</td>
<td>100%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>No BPD</td>
<td>52%</td>
<td>48%</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>63%</td>
<td>37%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*P Value* 0.000487