The Vermont Oxford Network and Care of Premature Infants

By: Christina Pool

When children are first born, they are helpless on their own. Under the best circumstances, a newborn is healthy and able to be taken care of by his or her parents. Too often, however, this best-case scenario does not happen. After a successful birth, a child faces any number of possible complications. One of the most common reasons for neonatal complications is prematurity. Out of the 4.3 million births that were registered in the United States during 2006, over half a million of those were premature (Martin). Premature infants, which have a gestational age of 37 weeks or less, have a reduced period of development. Because of this, premature neonates have the potential for a multitude of problems, such as Periventricular-Intraventricular Hemorrhage (PIH), Patent Ductus Arteriosus (PDA), and Respiratory Distress Syndrome (RDS). The possibility of these complications is the reason why the Northwest Texas Healthcare System directs all preterm births to the Neonatal Intensive Care Unit (NICU). Infants in NICU, whom need constant surveillance, can be under the care of physicians and nurses that specialize in child healthcare. Current standards of healthcare for premature infants is good, however the methods by which NICU cares for their patients can vary from hospital to hospital and physician to physician. Therefore, a network of volunteers that would become known as the Vermont Oxford Network was gathered together to unify the style of healthcare for premature infants and reach a common goal: improvement.

The Vermont Oxford Network is a non-profit collaboration of volunteer healthcare professions that are dedicated to the improvement of medical care for newborn infants and their families. It was first established in 1988 by Jerold F. Lucey, M.D., Jeffrey D. Horbar, M.D. and Roger F. Soll, M.D. Since then, the Vermont Oxford Network has gathered over 700 Neonatal Intensive Care Units in hospitals around the world, including North America, Europe, Asia, the

Pacific Rim, the Middle East, South America, and Africa, to build a database of information concerning the care and outcomes of newborn infants every year (VON). This database is compiled in order to provide reliable information to health care professionals in order to improve the safety and wellbeing of their patients. Those hospitals that participate in the Vermont Oxford Network have diverse teams that are charged with the task of collecting data on the various infants that are admitted and submitting that data to the designated databases.

There are two Vermont Oxford Network databases: VLBW (Very Low Birth Weight) Database and Expanded Database. VLBW Database requires neonates, whose birth weights are between 401 grams or 14 ounces and 1500 grams or 3 pounds, 4 ounces. Neonates, whose gestational age is between 22 weeks 0 days and 29 weeks and 6 days (inclusive), are also eligible for entry into the VLBW Database (VON). Infants have to meet either the birth weight or gestational age requirements in order to be a part of the VLBW Database. The Expanded Database includes infants eligible for VLBW Database as well as infants who have a birth weight over 1500 grams, regardless of gestational age. All infants must be admitted into the NICU within the first 28 days of life in order to be eligible for entry into either database (VON). In addition, stillborn infants are not eligible for entry into either database. This is due to the nature of the data collection, which includes questions on temperature, respiration, and other evidences of life that a stillborn child would not be able to demonstrate. The same criterion does not apply to those infants that die in the delivery room, as they have exhibited evidence of life.

Over the course of over 80 hours, I was one of several volunteers that teamed up with nurses and physicians to do data collection at Northwest Texas Hospital (NWTH) in Amarillo, Texas. Some of the individuals that I work with are Dr. Mubariz Naqvi, M.D., Esther Perkins, RN, and Andrea Burke, RN. For the first month, I was trained by both Esther and Andrea in

NWTH's particular method of data collection, and learned about the various terminologies that I would need to know. Most of the details regarding how to answer certain questions according to the Vermont Oxford Network's standards were handled by referencing the *"Vermont Oxford Network Manual of Operations for Infants Born in 2009,"* including the calculations for an infant's Length of Stay, and dates for the 28th day of stay and week 36 since conception. All babies that were submitted to the Vermont Oxford Network's databases were recorded in the Vermont Oxford Network Patient Log with reference to their Network ID number. Previously, Northwest Texas Hospital had done data collection for only the infants of the highest risk, those that weighed less than 1500 grams at birth. However, during the semester in which I participated, NWTH had begun to include all infants that were admitted into the NICU. Each infant admitted into NICU had its own Network identification number and data form packet that includes the following forms: Patient Data Booklet, 28 Day Form, Discharge Form and Supplemental Data Form. These forms covered some common factors that apply to all infants: birth weight, temperature, gestational age, APGAR scores, race of the mother, and prenatal care (VON). Data regarding those factors establish a base to which all following information can be compared in order to determine if an infant is improving or deteriorating. Of these common factors, gestational age and APGAR scoring seemed most critical to determining what type of care a neonate received during the length of its stay.

Gestational age is the period of time in which the embryo or fetus resides in the mother's womb, measured in weeks and days. While a normal gestational age for a full term infant would range anywhere from 38 to 42 weeks, most of the infants admitted into the NICU at NWTH were premature, with gestational ages less than 37 weeks. The Vermont Oxford Network considers two methods of determination for gestational age: obstetrical measures based on menstrual

period or prenatal ultrasound, and the neonatologist's estimate based on physical examination and gestational age exam (Ballard or Dubowitz exam) (VON). The former is the best estimate that the Vermont Oxford Network requires. Gestational age based on menstrual period is the length of time between the mother's last menstrual cycle and the date of birth, which is the traditional method of measurement (Zieve2). However, it depends on the accuracy of the mother's memory and a regular menstrual cycle. Obstetrical measures by ultrasound can increase the accuracy of gestational age through the measurement of certain fetus body parts, such as the head circumference and the length of the femur. However, this also depends on how early in the gestation the ultrasound was done as the growth of the fetus can vary depending on the type of care it has undergone. Measurement of gestational age, according to Ballard/Dubowitz examinations, includes evaluations of the baby's neuromuscular and physical maturity. A physician must appraise the infant's posture, flexibility and response, skin condition, development of the genitals, and other characteristics (Ballard). Each examination receives a score, which added together yield a number that corresponds with the gestational age in weeks (Ballard).

Regarding the healthcare for the neonate, gestational age is incredibly important so that physicians can know the stage of development at which the infant is likely to be at birth. Gestational age also tells physicians about the potential problems the infant is likely to have over the course of its medical treatment. For example, gestational weeks 25 to 28 include a large amount of the brain's development, as well as nervous system control of the fetal body and some maturity of the respiratory system, notably the presence of surfactant. An infant born prior to this stage has an incredibly high risk of respiratory problems and has an increased likelihood of mental retardation and long-term health problems. In addition, gestational age is associated with

certain birth weights and head circumferences, and with this knowledge, physicians can determine how much nutrition an infant needs to gain the appropriate weight if the birth weight is too low or, if the head circumference is too large, that they may need to check for hydrocephalus. NWTH's NICU uses the Ballard/Dubowitz examination for infants admitted, but this is also used in conjunction with the gestational age as determined by ultrasounds by the Labor and Delivery department of NWTH.

Of the several assessments an infant undergoes within the first few minutes of its life, many of them are absolute, such as birth weight and temperature, yet they are part of a measurement that determines the infant's current state of health. Likewise, APGAR scoring is an evaluation of an infant's health. APGAR was developed by Virginia Apgar, M.D. in 1953 to reestablish a "simple, clear classification or grading of newborn infants" (Apgar). Previously, terminology included terms like mild, moderate and severe, the interpretations of which varied from person to person in much the same way that the definitions of "frequently" and "often" fluctuate according to the person using them. Dr. Apgar provided a definitive method of evaluating the condition of an infant at birth using five easily determinable signs that could be rated from zero to two: heart rate, respiratory effort, reflex irritability, muscle tone and color. Once rated, the values of each sign are added together for a total APGAR score. Therefore, a baby receiving a total score of ten -- a rating of two for each of the five signs -- is in the best possible health and a score of eight or higher is in good or excellent condition (Apgar). Although Dr. Apgar originally only intended for scoring to be done 60 seconds after complete birth, most institutions now include an evaluation at 5 minutes after birth, since the 5-min APGAR score compares strongly with infant mortality (Finster). At NWTH, scoring is done at 1 minute, 5 minutes, and 10 minutes after birth, however the Vermont Oxford Network only

requires the 1-minute and 5-minute scores. APGAR scores have been used to determine the likelihood of an infant to develop neurological issues such as cerebral palsy, mental retardation and epilepsy, but the viability of this correlation has been disputed (Committee, Nelson). Even a consistently low APGAR of 3 or less for over 10 minutes despite active resuscitation does not guarantee the development of cerebral palsy in surviving infants (Nelson). Overall, APGAR scoring is best seen as an indicator of the infant's survival rate through the 28 days after birth and the level of initial resuscitation that will be needed (Apgar).

Over the course of an infant's stay at NICU, he or she is under constant supervision. During the course of this supervision, physicians look for any signs that might point to the ailments towards which their (primarily premature) infants have a predisposition. Some of these included Periventricular-Intraventricular Hemorrhage (PIH), Patent Ductus Arteriosus (PDA), and Respiratory Distress Syndrome (RDS) (VON).

Periventricular-Intraventricular Hemorrhage (PIH) is a serious brain injury in premature infants. Between gestational week 20 and week 32, the neurons and supporting cells that compose the fetal brain are migrating and proliferating. The germinal matrix supports the migration and proliferation of neurons through its highly vascularized nature, and as the formation of the brain becomes more complete, the germinal matrix eventually recedes (Annibale). Premature infants, however, have not yet reached the point at which the germinal matrix is completely diminished, and the web of capillaries in the germinal matrix is especially sensitive to any minute changes that might occur. A change in blood pressure or a change in the constituents of the blood could cause the capillaries in the germinal matrix to hemorrhage and bleed out. The Vermont Oxford Network first looks for the diagnostic imaging that the NICU may have performed to identify PIH, such as a cranial ultrasound, a cranial computed

tomography (CT) scan, or a cranial magnetic resonance imaging (MRI) (VON). The data form specifically asks if one of these techniques was used prior to the 28th day of the infant's stay. If the infant has undergone any of these imaging techniques, the PIH is then graded on a scale of zero to four according to the severity of the bleed as seen on the radiological images. While grade zero is recorded if there is no evidence of a hemorrhage, grades one through four cover a range of severities. The hemorrhage is restricted to the germinal matrix in grade one. As blood extends into the ventricles, grades two and three are recorded, with the latter also showing swelling, and grade four is an intraparenchymal hemorrhage (VON). Since PIH is rarely due to trauma in premature infants, treatment involves correction of the disturbance that may have led to the bleed in the first place (Annibale). Follow-up of hemorrhages is typically further cranial ultrasounds, CT scans or MRIs. Several courses of action can be taken in order to prevent PIH from occurring. Primarily, allowing the fetus to develop within the womb to full term is most desirable, but this is not always possible. Antenatal corticosteroids, which are a typical portion of prenatal care, are also used to increase the speed at which the fetus develops. Prenatal care and antenatal steroids, notably betamethazone, dexamethasone and hydrocortisone, are both part of the observations required by the Vermont Oxford Network.

Another piece of information that the Vermont Oxford Network looks for in its data collection is whether the infant shows evidence of a patent ductus arteriosus (PDA) and/or undergoes a PDA ligation at any point during his or her stay at the hospital. The ductus arteriosus is a blood vessel that connects the pulmonary artery, which leads to the lungs, and the aorta, which leads to the rest of the fetal body. This connection is only required by fetuses as their blood has been oxygenated by the mother and their fluid-filled lungs are cannot perform gas exchange. The ductus arteriosus allows the blood to bypass the fetus's lungs altogether. After

the baby is born, it begins to breathe on its own, the redirection of oxygenated blood is no longer required, and the ductus arteriosus should begin to close on its own. If the ductus arteriosus remains open after birth, the prenatal blood flow from pulmonary artery to the aorta reverses, so that oxygenated blood is now entering the pulmonary artery from the aorta. While a small PDA can be asymptomatic, most infants show some of the following symptoms: fast breathing, bounding pulse, and tiring very easily (Zieve1). This is due to the amount of blood that is not being oxygenated and thus, not carrying oxygen to the tissues. The infant's breathing increases in order to oxygenate more blood, the heart rate quickens in order to increase the amount of oxygenated blood reaching the tissues, and without enough oxygen to help cells regenerate energy, the infant's body becomes tired very quickly. Diagnosis of PDA is usually done with an echocardiogram or chest x-ray (Zieve1). An echocardiogram would show the PDA, and a chest x-ray would show the possible enlargement of the heart. For the purposes of the Vermont Oxford Network's data collection, clinical evidence of a PDA has to be documented by a "continuous murmur, hyperdynamic precordium, bounding pulses, wide pulse pressure, congestive heart failure, increased pulmonary vasculature or cardiomegaly by chest x-ray, and/or increased oxygen requirement or ECHO evidence of PDA" (VON). The objective of any treatment for PDA would be to seal off the ductus arteriosus to prevent flow between the pulmonary artery and the aorta and to ensure that circulation becomes as normal as possible. A PDA ligation is a particular corrective heart surgery that infants must undergo in the event that the blood vessel, ductus arteriosus, does not close after birth. Treatments like PDA ligations involve the insertion of a device into the ductus arteriosus to block blood flow, or the tying off and removal of the artery itself (Kaneshiro). It is possible to treat PDA with medications, and

while the Vermont Oxford Network data forms have the option of verifying treatment of PDA with indomethacin, NWTH has not performed this treatment during the year 2009 (VON).

In addition to PIH and PDA, Respiratory Distress Syndrome (RDS) is another ailment that can affect premature infants. For the Vermont Oxford Network, an infant is defined as having RDS when it has PaO2 less than 50 mmHg with room air, central cyanosis in room air, a necessity for additional oxygen to maintain a PaO2 greater than 50mmHg, or a blood oxygenation level over 85% within the first 24 hours of life (VON). The Vermont Oxford Network also considers an infant to have RDS if he or she has "a chest radiograph consistent with RDS (reticulogranular appearance to lung fields with or without low lung volumes and air bronchograms) within the first 24 hours of life" (VON). RDS is most commonly seen in premature infants whose lungs have not completely developed or have not begun to secrete surfactant (Greene). Surfactant is the lubricating substance that lines the surfaces of the lungs, decreasing the friction between the alveoli, or air sacs. Without surfactant, the alveoli would not be able to expand against each other in order to fill with air and the infant would develop breathing problems. In addition to prematurity, other factors can also contribute to the onset of RDS in neonates: cesarean delivery, multiple pregnancy, and diabetes in the mother (Greene). All three of these factors are also to be made note of in the Vermont Oxford Network forms (VON). The symptoms of RDS reflect the inability of the infant to expand its lungs and receive the maximum amount of oxygen, such as cyanosis, rapid breathing and apnea (Greene). Cyanosis is a blue tint to the baby's skin and mucus membranes, which is caused by the low oxygenation of blood. The infant breathes rapidly in order to compensate for the low amount of oxygen is reaching the tissues and apnea, or brief cessations in breathing, can be caused by the inability of the child to inhale. At NWTH, low oxygen levels and apnea were likely to be among

the first symptoms to be noted by the attending physicians and nurses. Confirmation of an RDS

diagnosis is done through a chest x-ray, which will show the "ground glass appearance" that is

the collapsed alveoli in the lungs (Greene). Treatment of RDS involves administration of

surfactant and warm, moist oxygen, both of which the Vermont Oxford Network want to have

noted in their data collection along with the method of dispensation. NWTH administers

surfactant after the diagnosis of RDS has been confirmed. This form of rescue surfactant

treatment will reduce the severity and frequency of RDS in the patient (Engle). The surfactant

administered at NWTH is derived from bovine surfactant. Studies show that it is no less

effective at counteracting RDS than synthetic forms of surfactant (Engle). Oxygen is

administered to infants through continuous positive airway pressure (CPAP), which keeps the

oxygen under a slight amount of positive pressure in order to keep the alveoli open and prevent

the need for a breathing machine in the future.

The Vermont Oxford Network's data collection covers a wide range of factors that

contribute to possible problems that may surface over the duration of an infant's stay. The few

topics covered here -- gestational age, APGAR scores, periventricular-intraventricular

hemorrhage, patent ductus arteriosus, and respiratory distress syndrome -- covers some but not

all of the ailments that the Vermont Oxford Network wishes to dissect. The questions in the

Network data forms also include topics on multiple gestations, retinopathy of prematurity,

bacterial sepsis, method of resuscitation and birth defects. The information that the Vermont

Oxford Network VLBW and Expanded Databases provide have been the invaluable source for

over 100 different studies (VON). All the members of the Vermont Oxford Network put forth all

their efforts to provide accurate information to the database to contribute to the continued

improvement in healthcare for infants and their families.

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