12

Preterm Birth of Extremely Low Birth Weight Infants

Jonathan Muraskas, Lisa DeGregoris,
Colleen Rusciolelli and Christine Sajous
Loyola University Medical Center
USA

1. Introduction

Approximately 13% of births in the United States are preterm, defined as occurring before 37 weeks of gestation. This results in more than 540,000 infants a year born prematurely. In other words, one out of every 8 infants is born premature. Even more disturbing is that despite advances in neonatal and perinatal medicine, the incidence of prematurity has increased by 36% since the 1980's. Over 1 million infants die worldwide every year because of consequences that are related to being born too soon. Every 30 seconds one infant dies of preterm birth. Approximately 1.5% of infants in the United States are born less than 27 weeks gestation which accounts for approximately 100,000 infants annually. Even infants born just a few weeks too soon (34-36 weeks gestations), also known as late preterm birth, have higher rates of death and disability than full term infants. Table 1 describes the evolution of technology in the obstetrical and pediatric management of premature birth in the United States in the last 60 years.

1940-50	Infants < 1 kg were classified as stillborn
1950's	Introduction of Apgar scores made these infants live-born but previable and allowed to die without technologic intervention
1960's	1 kg limit persisted until the widespread use of mechanical ventilation in the late 1960's
1970's	Limit of viability started rolling back
1980's	Survivors with Gestational Age (GA) of 24 weeks and Birth Weight (BW) of 500-600g were rare
1990's	Introduction of Surfactant/antenatal steroids Survivors with GA's of 24 weeks and BW's of 500-600g were common
2000's	Conflict

Table 1. Evolution of Neonatal-Perinatal Medicine

Very low birth weight (VLBW) infants are defined as weighing less than 1500 grams. Extremely low birth weight (ELBW) infants are defined as being less than 1000 grams.
Table 2 correlates GA with BW in appropriate for gestational age (AGA) ELBW infants.

ONE POUND = 454 GRAMS AGA	
23 weeks	450 – 550 grams
24 weeks	500 – 650 grams
25 weeks	600 – 750 grams
26 weeks	700 – 850 grams
27 weeks	850 – 950 grams

Table 2. Correlation of Birth Weight with Gestational Age

Introduction of surfactant and antenatal steroids in the early 1990's have dramatically changed the field of neonatal-perinatal medicine. Dramatic increases in the survival of ELBW infants with a concomitant decrease of severe intraventricular hemorrhage (IVH) became the norm. The duration of mechanical ventilation dramatically decreased. In the last two decades, advances in perinatal and neonatal care have reached the point where an infant at 27 weeks gestation weighing 2 pounds (900 grams) has over a 90% chance of surviving and less than a 10% chance of a devastating handicap. Unfortunately, long-term outcomes in infants less than 27 weeks have not shown significant improvement over the years. The application of neonatal intensive care to extremely premature infants less than 27 weeks' gestation is a fundamental controversy in neonatology. Rates of death and numerous morbidities such as chronic lung disease, intracranial hemorrhage, and retinopathy of prematurity are distressingly high. Frequently long-term neurodevelopmental outcomes for these infants born before 27 weeks are very poor. It has been our experience that antenatal exposure to steroids, female gender and delivery by cesarean section have been positive prognostic variables in many extremely low birth weight infants with intact survival.

2. Economics

Although VLBW and ELBW infants account for 1.5% and 0.7% of all live births respectively, these infants contribute disproportionately to neonatal morbidity and to health care costs. Approximately 85% of infants with very low birth weights survive to be discharged from the hospital. Within 2 years after discharge, 2-5% die from medical complications related to preterm birth.

In the United States, approximately 40% of the estimated 6,600 cases of cerebral palsy that are diagnosed each year are a direct result of very low birth weight. Helping these fragile infants survive and thrive comes with a price tag. Preterm birth is a serious health problem that costs the United States more than $26 billion annually. With the incidence of prematurity increasing and smaller and smaller infants being resuscitated, the incidence of cerebral palsy is increasing. There appears to be no reprieve from the extraordinary cost of care that will be needed to manage the medical, educational and special services for this large proportion of extremely low birth weight infants who develop chronic conditions. With increasing discussion of healthcare reform and intensive care for infants exceeding $4000.00 per day, we believe the health care resources currently debated for senior citizens will also lead to rigorous debates at the other end of the spectrum of life in the near future. Many argue that money spent on numerous resources to save the tiniest of infants who develop profound handicaps could be better spent on the education and prenatal care of the pregnant woman, thereby positively impacting the incidence of prematurity and the infant mortality rate.

3. Multiple gestation and preterm birth

Multiple gestations have significantly contributed to the increasing prematurity rate. Since the 1980s, there has been a 65% increase in twin and over 500% increase in triplet births. In the United States, approximately 130,000 infants are born annually of multi-fetal gestation. Roughly 1% of all U.S. infants born annually are conceived by assisted reproductive techniques. Career advancements often delay the starting of a family in early childbearing years. Another reason has also been the significant advancements in the field of infertility and reproductive medicine.

Any multiple gestation is a high-risk pregnancy. Each fetus in multiple gestations shortens the duration of pregnancy by 2 to 3 weeks. A term twin pregnancy is considered 37 weeks gestation. In our experience, the majority of triplets deliver at approximately 33 weeks gestation. Quadruplets and higher order pregnancies sequentially decrease gestational age at delivery by another 2 weeks. Quadruplets would deliver on average at 31 weeks gestation and physiologically, octuplets would be expected to deliver at 23 weeks gestation. The incidence of cerebral palsy and long-term neurologic deficits for twins, triplets and quadruplets are 3.7%, 8.7%, and 11.1%, respectively. With twins the chances of one handicapped child is 7% while triplets and quadruplets are 20 and 50% respectively. The relative risks for severe handicap for twins and triplets is 1.7 and 2.9 compared to singletons The infant mortality rate for singletons, twins and triplets are approximately 9, 57, and 166 per thousand live births, respectively.

4. Initial management

The management of ELBW infants in a neonatal intensive care unit can be stressful. The most common cause of clinical decompensation in these infants is the inability to achieve an adequate airway. In the United States, there are over 4 million births annually. Approximately 10% of all infants born, including low risk deliveries, will require resuscitation. The percentage is significantly higher with extremely low birth weight infants. At least one person skilled in resuscitation should be present at all deliveries. The resuscitation of an ELBW infant requires the teamwork of a physician/neonatal nurse practitioner, neonatal nurse and often a respiratory therapist. The procedural skill of intubation can be difficult even in the most experienced hands. For this reason practitioners in this field should be skilled in bag and mask ventilation. This can be done effectively until someone more skilled with intubation can establish an airway. In a situation of bradycardia and desaturations, practitioners need to assume the endotracheal tube is not in place and be willing to reevaluate, calmly bag and mask and attempt to reintubate. In our experience, chest compressions are rarely indicated in a clinically deteriorating infant. The establishment of adequate airway will usually rectify this clinical decompensation with restoration of normal heart rate and oxygen saturations.

With the advent of surfactant, steroids and gentle ventilation, the incidence of airleak has been significantly reduced in the last two decades. When an adequate airway is achieved and the infant does not respond to resuscitation, one needs to expediently consider a pneumothorax in the differential diagnoses. An unrecognized airleak is one of the most frequent etiologies for sudden death in an unsuccessful infant resuscitation. A tension pneumothorax is an acute life-threatening event that may not allow time for x-ray confirmation. For this reason practitioners should be skilled in needle aspiration of the pleural cavity. Like intubation, placement of chest tubes can be a difficult procedural skill.

The ability to transilluminate and promptly insert a 23-gauge butterfly needle lateral to the nipple can be life-saving. These basic skills are especially in a community or rural hospital when 24/7 neonatal coverage is not feasible.

5. Common complications

5.1 Respiratory distress syndrome

The most common complication of prematurity is respiratory distress syndrome. This is a deficiency of pulmonary surfactant that results in the alveolar collapse, uneven aeration, ventilation/perfusion mismatch and increased alveolar-capillary membrane permeability. These infants can present with tachypnea, grunting, nasal flaring, and substernal retractions. Pathological findings include necrosis of the cell lining of the airways, proteinaceous exudate forming hyaline membranes and infiltration of inflammatory cells within the airway. The incidence and severity of respiratory distress syndrome has been greatly reduced with antenatal steroids and surfactant therapy. Despite this, the incidence of chronic lung disease, as well as neurodevelopmental disability, in an extremely low birth weight infant has not decreased.

5.2 Intraventricular hemorrhage

Intraventricular hemorrhage (IVH) in preterm infants has decreased in recent years in most neonatal centers. The incidence ranges from 29-49% of all infants less than 1500 g. IVH is mainly a complication of infants with a birth weight less than 1000 g and especially those whose weight is less than 750 g. The majority of IVH occurs in the first 72 hours of life. The exact etiology remains unknown although poor cerebral autoregulation is implicated, especially in ELBW infants. IVH is graded from 1 through 4. A grade 1 represents a subependymal hemorrhage while a grade 2 involves IVH without ventricular dilatation. A grade 3 IVH has blood in the ventricle but with concomitant ventricular dilatation. The most severe is a grade 4 IVH in which there is extension of the bleed into the brain parenchyma. Grades 1 and 2 IVH have excellent prognosis for normal development. Grade 3 IVH, especially with hydrocephalus significant enough to require a shunt, has at least a 50% risk of mental retardation or cerebral palsy. A grade 4 IVH carries an 85% risk for a significant devastating handicap. The use of antenatal steroids has positively impacted the incidence of severe grade 3 or grade 4 IVH. However delivery of ELBW infants can be precipitous and usually antenatal steroids take approximately 24 hours to exert accelerated maturation of the germinal matrix and lungs. Cerebral palsy is often not diagnosed well after the first year of life and sometimes not until 2 years of age.

5.3 Retinopathy of prematurity

Retinopathy of prematurity (ROP) is a developmental disease which occurs mainly in the incompletely vascularized retina of premature infants and can progress to retinal detachment. Prematurity is the most important risk factor for ROP. The incidence of retinopathy of prematurity is over 80% in infants less than 1000 g. The incidence of blindness approaches 10%. The international classification of ROP defines the location by zones, the extent by clock hours, and the severity by stages. Special pathologic features are defined by the terms plus disease and threshold disease. The only effective prophylaxis for ROP is the prevention of prematurity. Meticulous oxygen monitoring has not provided a complete solution and various supplements such as vitamin E and selenium therapy have

not proven effective. All infants born less than 33 weeks gestation should have an eye exam regardless of oxygen requirement. The first eye exam occurs at 4-6 weeks chronologic age. Frequency of eye exams depends on the severity and rate of progression of retinopathy.

5.4 Patent ductus arteriosus

Patent ductus arteriosus (PDA) is another common complication of extremely low birth weight infants. The Ductus Arteriosus represents an embryological connection between the aorta and pulmonary artery. This duct remains open and clinically presents past the first 3 or 5 days of life in 50% of all ELBW infants, often with increasing oxygen requirements and metabolic acidosis. Infants can present with bounding pulses, wide pulse pressure and a classic machinery-type murmur. Physiologically this duct can augment a left-to-right shunt increasing pulmonary blood flow. Given the potential for decreased blood flow to the intestines, many clinicians are reluctant to feed infants with clinically significant PDAs. Approximately 70-80% of ductuses will respond to medical therapy that has included prostaglandin inhibitors such as indomethacin and ibuprofen. These prostaglandin inhibitors constrict the smooth muscle of the ductus arteriosus. The efficacy of this treatment is greater when initiated within 10 days of life. As with many medications, complications with prostaglandin inhibitors include thrombocytopenia, hyperbilirubinemia and impaired renal function. Prostaglandin inhibitors may further decrease blood flow to the bowel and some studies have reported a higher incidence of spontaneous intestinal perforations and other GI symptoms with this treatment. Ibuprofen is as efficacious as Indomethacin with less renal side effects. Surgical ligation is reserved for those infants who did not respond to medical management concomitant with deteriorating clinical status often with increasing ventilatory requirements because of increased pulmonary blood flow. In most ELBW infants we choose to have ligation performed at the bedside in the NICU. There is recent data now questioning the concept of mandatory closure for all ductuses.

5.5 Sepsis

Maternal chorioamnionitis can have significant effects on the ELBW infant. One of the more common etiologies for preterm birth is maternal infection. Intra-amniotic infection is perhaps the most common cause for an infant born depressed requiring resuscitation. Evidence-based data has demonstrated a strong relationship between chorioamnionitis and subsequent brain damage in both preterm and term infants. Through a cytokine mediated pathway, white matter is especially vulnerable in the infant exposed to maternal infection. Periventricular leukomalacia can result in spastic diplegia and other significant neurodevelopmental disabilities.

A common complication in ELBW infants in the intensive care unit is infection. Approximately 40-50% of ELBW infants will develop an infection. With an already compromised immune system, extremely low birth weight infants undergo multiple instrumentations with endotracheal tubes and central lines. We discuss with parents that it is not unusual for an ELBW infant to have feedings stopped and antibiotics started at least 2-3 times during their neonatal hospital course to rule out an infectious process.

Sepsis neonatorum is defined as any bacterial infection with systemic manifestations which is documented by a positive blood culture during the first month of life. Neonatal sepsis can be classified into 2 categories based on postnatal age at onset: Early onset less than 7 days and late onset greater than 7 days. The incidence of sepsis varies between 1-8 cases per

thousand live births. Prevalence increases inversely with gestational age affecting 25-40% of extremely low birth weight infants. Mortality rates are 10-30% for early onset and 10% for late onset sepsis. Currently group B streptococcus, gram-negative bacilli and Listeria monocytogenes are most commonly associated with early onset sepsis whereas enterococcus, coagulase-negative staphylcoccus and gram-negative bacilli are more frequently responsible for late onset sepsis. Most episodes of early onset sepsis are caused by an ascending infection with the exception of Listeria which is transmitted transplacentally. Infection could also be acquired during vaginal delivery from bacteria colonizing the mother's genital tract. The bacteria causing late onset disease may be transmitted either vertically during the peripartum period or horizontally from all one might see in the environment or from colonized caregivers. Inadequate handwashing can be a major source for the spread of microorganisms from one patient to another. The use of endotracheal tubes, central venous and arterial lines and Foley catheters also significantly increase the risk for neonatal infection.

In our experience, a low WBC count and band/seg ratio > 0.2 is more ominous than a high WBC count. The absolute neutrophil count calculated by WBC x % (Segs and Bands) less than 2000 could suggest an infectious process. Thrombocytopenia is defined as a platelet count less than 150,000/ul. Although thrombocytopenia is present in 80% of cases of sepsis, it has a low sensitivity and specificity. A blood culture is the gold standard to diagnose neonatal sepsis and should be drawn from both central and peripheral lines. If the clinical signs and symptoms are suggesting meningitis or if the blood cultures are positive, a lumbar puncture should always be performed. It seems reasonable not to perform a lumbar puncture on the infant being evaluated only because of maternal risk factors or the infants with respiratory distress syndrome. When the clinical suspicion of sepsis is high, empiric antimicrobial therapy should be started immediately after obtaining the appropriate culture specimens. The choice of empiric therapy is based on several factors including time and setting of the disease, microorganism frequency and susceptibility in your NICU, the site of the suspected infection and penetration of the specific antibiotic to that site, and hepatic and/or renal dysfunction.

5.6 Necrotizing enterocolitis

Another feared complication of preterm birth is necrotizing enterocolitis (NEC). NEC is an inflammatory process resulting from a complex interaction between the mucosal injury caused by a variety of factors such as infection and ischemia and the host response to that injury. NEC is the most common gastrointestinal emergency in the NICU. The incidence of NEC is approximately 10% of all NICU admissions. The majority of NEC manifest between 2-4 weeks of life, usually in the preterm infants who have been fed. Approximately 80% of cases of NEC respond to antibiotics and cessation of feeding while 20% will go on to perforate requiring an operation. Mortality can be as high as 40% despite vigorous therapy. Infection, inflammatory mediators, ischemia and enteral feeds have all been associated with NEC, although the etiology remains elusive despite significant research. Breastmilk macrophages and immunoglobulins were thought to prevent NEC; however exclusively breast-fed infants have occasionally developed NEC. Premature infants can have various presentations with the onset of NEC. These can include vomiting, abdominal distention, apnea, bile stain residuals and bloody stools. Peritoneal signs such as abdominal distention, tenderness and guarding are frequently observed. Radiographically

pneumatosis intestinalis appearing as soap bubbles or linear intramural streaks especially in the right lower quadrant of preterm infants is pathognomonic. Ileal perforation can manifest by abdominal free air. Portal air which represents tracking of air through the bowel wall along the mesenteric vessels and into the portal system can be associated with NEC. In our experience, the presence of thrombocytopenia and metabolic acidosis is highly suggestive of necrotic bowel.

The initial treatment especially with signs of peritonitis includes triple antibiotic therapy and meticulous fluid and electrolyte management. Infants with NEC may develop disseminated intravascular coagulation (DIC) and/or thrombocytopenia requiring blood products. Surgical management has changed over the last decade. More often than not peritoneal drain placement is preferred to stabilize these critically ill infants before considering surgery. Late complications of NEC include intestinal strictures, bowel obstruction and malabsorption. A certain amount of small intestine is necessary for survival. Short gut syndrome is not uncommon and full recovery can take months to years.

5.7 Bronchopulmonary dysplasia

Bronchopulmonary dysplasia (BPD) is a multifactorial disease defined as any infant requiring oxygen beyond 28 days of life or 36 weeks post-conceptional age. Risk factors include barotrauma, prolonged oxygen requirements resulting in free radical induced oxygen toxicity and recurrent infections thought to release cytokine inflammatory mediators. BPD is usually accompanied by an abnormal chest x-ray and clinical signs of respiratory distress. Up to 75% of infants of extremely low birth weight develop BPD. The incidence of BPD has remained unchanged although the severity has declined somewhat. BPD is a spectrum in which there could be minimal oxygen requirement or a ventilator dependency often requiring a tracheostomy in severe cases. Major complications of BPD can include developmental delay, poor growth, heart failure, pulmonary edema and gastrointestinal reflux. Toddlers with the history of BPD have a significantly higher incidence of reactive airway disease and require frequent hospital readmissions. Respiratory syncytial virus (RSV) can be deadly in a neo graduate with BPD. Premature infants that meet criteria for palivizumab (Synagis) administration should receive this throughout the RSV season to help prevent serious infection and respiratory compromise. There are many treatment regimens for BPD. Parents need to be told that many infants who are extremely low birth weight will often require oxygen at home.

5.8 Seizures

Neonatal seizures can complicate the hospital course of an ELBW infant. Newborn seizures can be difficult to clinically diagnose due to subtle abnormal ocular and focal movements. Subtle motor abnormalities with concomitant desaturations and/or apnea often represent seizure activity. One needs to be vigilant and anticipate risk factors such as a difficult resuscitation or the evolution of an intraventricular hemorrhage as a precipitating event leading to seizures. The first line of medication in the treatment of seizures is phenobarbital at a loading dose of 20 mg/kilogram to achieve therapeutic levels of 20-40 mcg/milliliter. Persistent seizures may require the addition of phenytoin or lorazepam (Ativan). Inadequately treated seizures can result in permanent neuronal cell damage due to enhanced metabolic activity.

5.9 Medication errors

Medication errors are preventable events that frequently occur in the NICU. It has been reported that out of every five adverse drug events in pediatric patients, three of those events occurred in the neonatal intensive care. Errors are particularly dangerous in the NICU due to the fragile state of infants. A rapidly changing body weight, different rates of organ development affecting drug pharmacokinetics and the need for dilution of medications contributed to the common occurrence of medication errors in the management of extremely low birth weight infants. Medication errors most commonly result from incorrect dosing, documentation, or processing. With the advent of computerized order entry, reduction of ordering errors is expected due to standardized templates for physicians and nurses. The computerized system also provides an additional way to intercept errors before they affect an infant.

6. Regionalization

Obstetrical and neonatal management of preterm birth often requires advanced services that are not available at all hospitals. Levels I, II, II+ and community hospital Level III intensive care units have set policies and regulations overseen by the regional perinatal center. The lack of experience in a low volume nursery can lead to catastrophic outcomes. Regionalization continues to have a role and is in the best interest of mother and her infant. The best ambulance for ELBW infants is the uterus. An effective maternal transport system in the United States has had a positive impact in the morbidity and mortality of ELBW infants. Studies support delivery of ELBW newborns in tertiary centers with better outcome than Level 2 or 2+ centers.

7. Outcomes

Table 3 describes the neonatal survival and outcomes for infants 22-30 weeks gestation. Clinicians today routinely provide intensive care for infants greater than or equal to 25 weeks gestation and over 750 grams birth weight. The survival rate exceeds 75% and the risk of a devastating handicap as blindness, deafness, cerebral palsy and mental retardation is 15% while the risk of a mild to moderate handicap such as learning disabilities, chronic lung disease, and milder forms of cerebral palsy is approximately 40%. Infants born less than 25 weeks gestation are considered at the threshold of viability. There are many uncertainties regarding resuscitation and management decisions. Currently there is no consensus on early treatment strategies that can currently predict which infants will thrive and which will have severe morbidity based on observations in the delivery room and throughout the first 48 hours of life. With steroid and surfactant technology, many infants after initial stabilization tend to have a honeymoon period where they remain hemodynamically stable often for the first 3 days of life followed by clinical deterioration secondary to a hemodynamically significant patent ductus arteriosus, intraventricular hemorrhage, reduced pulmonary function secondary to surfactant depletion, abnormal electrolytes or sepsis. It can be difficult for parents to get off this treatment train as these ELBW infants survive beyond the first 48 hours of life, regardless of how poor the prognosis is. ELBW infants born prior to 1990 often would die in the first 2 days of life. The median length of stay of ELBW infants who die has increased from 2 to10 days in the last two decades.

Weeks	NICU Survival	Survivors with Severe NDI*	Overall Survival **WITHOUT** Severe NDI*
22	10%	50%	5%
23	30%	33%	20%
24	60%	25%	45%
25	75%	15%	60%
26	80%	15%	70%
27	90%	10%	80%
28	90%	10%	85%
29	95%	5%	90%
30	95%	< 5%	> 90%

*NDI = Neurodevelopmental Impairment

Table 3. Estimated neonatal outcomes
Data derived for Loyola Medical Center, Vermont Oxford Network, and the National Institute of Child Health and Human Development (2010)
Last column reflects both survival and outcome of 100 infants born at given GA, how many will survive and not be severely impaired.
Severe NDI = Any of: significant developmental disability, mental retardation, non-ambulatory CP, blindness, deafness.
Other prenatal factors to consider:

SGA (Small for Gestational Age)/IUGR (Intrauterine Growth Restriction)
Gender
Infection

Approximately 23% of all infants less than 26 weeks gestation will have a severe disability defined as the expectation that a child will never be able to independently perform the activities of daily living. Infants born prematurely at less than 25 weeks gestation continue to present complex and unique medical, social, ethical and economical issues. As noted, despite a dramatic increase in survival, satisfactory long-term outcomes have not kept pace. Numerous studies of long-term follow-up have shown that ELBW infants have over a 50% chance at school age to have a childhood disability, school related disability, and the increased utilization of special educational needs. Low birth weight infants followed into adulthood had lower rates of graduation, a lower mean IQ, and subnormal growth. Extremely low birth weight infants who had the benefit of advanced technologies in the 1990's also continued to have a greater than 50% incidence of continuing to display more cognitive, educational, and behavioral impairments compared to controls. Other studies have shown that infants born in the 1990's had a significantly higher incidence of asthma, cerebral palsy, visual disability, poor cognitive ability, lower academic achievement, decreased motor skills, and poor social adaptive functioning compared to controls.

8. Neonatal viability

TABLE 4 demonstrates some variables that have been used in defining the limits of viability. From an ethical standpoint, most obstetricians and neonatologists consider infants greater than or equal to 25 weeks gestation viable and will intervene and resuscitate independent of parents' wishes on the grounds this is in the best interest of their infant. Where futility and autonomy meet is often described as a gray zone. In neonatal-perinatal medicine, this area is

most often encountered at 23-24 weeks gestation with infants 450-600 grams. Different strategies have evolved worldwide to address these issues. The United States has often been criticized for the "wait until certainty" strategy, treating everyone aggressively until it is virtually certain that either death or an irreversible coma will be the result. The United Kingdom tends more towards the individualized prognostic strategy where treatment is initiated and regularly re-evaluated as to its efficacy. In Norway and Sweden, a statistical prognostic strategy is often employed and treatment is withheld from infants who appear to have a grim prognosis. There is no simple solution and this topic will continue to be debated. It has been stated that parents really fear a burdensome outcome more than the death of their infant. Advances in neonatology have far outpaced decision-making practices in the NICU. Past personal experiences, religious perspectives, Baby Doe legislation, and fear of litigation can all influence decision-making.

1) Gestational Age
2) Birth Weight
3) Parents' Desires
4) History of Infertility
5) Method of Payment
6) Infant's Sex
7) Response to Resuscitation
8) Findings on Cranial Ultrasound

Table 4. Defining limits of viability.

Neonatal viability has no consistent definition. Fetal viability is the earliest gestational age at which the potential for long-term survival can be expected. The legal definition of viability is provided by each state rather than the federal government and varies considerably. The ethical definition of viability is described as a gray zone in which long-term survival is desirable but often not possible. In 1992 a survey of maternal fetal medicine specialists in North America found that 100% did not think viability began at less than 24 weeks. A similar survey 10 years later revealed that almost 50% of maternal fetal medicine specialist now believed viability began before 24 weeks.

Many studies can be deceiving in how parents are counseled. The denominator can vary widely to include all births (stillbirths and liveborns), only liveborns or only liveborns that lived long enough to be admitted to NICU. Survival can be overstated by as much as 100% at 23 weeks gestation and 56% at 24 weeks gestation if the denominator included only newborns admitted to NICU versus all fetal deaths and liveborns. The Ballard estimate of gestational age (GA) can yield a GA 10 days older than age determined by best obstetrical estimate. Sex is rarely considered in the numerous studies. The intact survival at 23 weeks GA is 5-10% (approximately 1 pound infant)and increases to near 90% at 27 weeks GA (2 pound infant). One can see how a few days can have significant effect on survival. This 23-24 weeks gestation is filled with ambiguity. We also emphasize that GA and not BW is perhaps the most critical factor in assessing viability. Almost all 100 intact surviving infants in the University of Iowa Hospitals The Tiniest Babies Registry weighing from 260 grams to 400 grams had significant intrauterine growth restriction and were females.

Retrospective nonrandomized studies have consistently failed to document a benefit of cesarean section versus normal spontaneous vaginal delivery for ELBW newborns. A scenario we see is the 23-24 week GA fetus in the breech position where cesarean section (a major surgery) is often not recommended because of poor neonatal outcome.

The National Institute of Health consensus is offering antenatal steroids between 24 and 34 weeks of gestation for a single course. There is controversy and limited data if maternal steroids should be administered prior to 24 weeks GA. If aggressive resuscitation is requested by families at less than 24 weeks GA, we would prefer managing these micropremies with steroids on board.

We believe each case of viability needs to be considered individually. The majority of infants whether born at 18 or 24 weeks will often have a heart rate at birth. The World Health Organization has determined that these infants should be classified as live births. Parents need to be told that infants can have a heart rate for minutes to hours after birth despite being nonviable. This can become problematic in that ELBW infants initially pronounced dead have been later resuscitated after having gasping respirations or being stimulated by a cold steel utility sink, resulting in survival with devastating handicaps. Some institutions continue to use 500 g as the cutoff to initiate or withhold resuscitation.

9. Ethics

Preterm birth has resulted in some interesting landmark ethical cases. In 1995, a 25 week gestational age male was born in Michigan weighing 780 g and was resuscitated against the parents' wishes. The infant was born by C-section after an attempted vaginal birth (VBAC) and came out requiring significant resuscitation. Shortly after birth the parents disconnected the ventilator for fear of having a handicapped child. This infant expired soon afterwards. The physician father was found not guilty of manslaughter. A 1999 case in Texas involved a 23 week gestation 595 g infant male in which resuscitation was attempted but an adequate airway was not achieved. This infant was deemed nonviable. The dilemma arose when this infant was given a large dose of fentanyl to expedite death. Another case involved a 23 week gestation 629 g infant female born in Texas in 1990. The parents refused to sign a consent to allow resuscitation of their 23 week infant daughter. They did not want heroic measures and did not want a neonatologist to attend the delivery. The parents were told the hospital had a policy that all newborns who weighed greater than or equal to 500 g were resuscitated and the parents did not sign the consent to allow resuscitation. The fellow on call resuscitated this infant female with Apgars of 3 and 6. At 7 years of age, this child could not walk, talk, was blind with severe mental retardation and cerebral palsy. This child had seizures, spastic quadriplegia, ventriculoperitoneal shunt and could not be toilet trained. The parents did not sue the physicians but the hospital for battery and negligence saying the doctors did what they were told. The initial jury verdict award was $60 million to the parents. The Texas court of appeals reversed this decision saying the parents could withhold treatment from a child only after their child's medical condition has been certified as terminal under the Texas natural death law. If treatment is urgent, a court order is not necessary to treat.

Medical care, therapy and interventions in the periviable period are based largely on extrapolation of information from infants born at greater gestational ages. Most interventions in the NICU, including resuscitation, can be classified as experimental. All infant cases of viability need to be individualized. We teach our housestaff to resuscitate if any doubt exists. The delivery room is often not the arena to be making decisions on withholding or withdrawing life support.

Good communication between the obstetrician/neonatologist and family is critical. Whenever possible, discussion regarding resuscitation should be initiated before delivery. Survival rates can vary institutionally and one needs to be aware of the local and national data in these discussions. We believe parents should have a significant input in the decisions

concerning the management of their extremely low birth weight infants. Medical, legal and ethical arguments would strongly support clinicians for not practicing defensive medicine. Because of fear of liability, neonatologists, more often than not, respect the parents' wishes regarding their infant's care. The risk of professional liability is minimal for non-aggressive management of infants born less than 25 weeks gestation and less than or equal to 650 grams AGA. Good communication, documentation, and a compassionate caring attitude make professional liability essentially nonexistent.

10. Conclusion

In the last 2 decades survival rates of ELBW infants has plateaued with neurodevelopmental outcomes essentially unchanged. The use of nitric oxide, noninvasive ventilation, more judicious use of steroids, and providing a quieter more family friendly intensive care unit are exciting new developments in our field. The future care of ELBW infants will be exciting for the next generation of practitioners in our field. Will technology keep advancing? How much more can we push the envelope of viability? Caring for the high risk mother and infant is an honor and privilege. If we remain competent, compassionate and caring, we can continue to positively impact future generations.

11. References

Ballard DW, Li Y, Evans J, Ballard RA, Ubel PA. Fear of litigation may increase resuscitation of infants born near the limits of viability. J Pediatr 2002; 140:713-718.

Berghella V. Every 30 seconds a baby dies of preterm birth. What are you doing about it? AJOG 2010; 416-417.

Eichenwald EC, Stark AR. Management and Outcomes of Very Low Birth Weight. N Engl J Med 2008; 358:1700-1711.

Frogel M, et al. Prevention of hospitalization due to respiratory syncytial virus: Results from the Palivizumab Outcomes Registry. J Perinatol 2008; 28:511-517.

Meadow W. 500-Gram Infants – and 800-Pound Gorillas - in the Delivery Room. Pediatrics 2006; 117: 2274-2275.

Meadow W, Lee G, Lin K, Lantos J. Changes in Mortality for Extremely Low Birth Weight Infants in the 1990s: Implications for Treatment Decisions and Resource Use. Pediatrics 2004; 113:1223-1229.

Muraskas J, Carlson N, Halsey C, Frederiksen M, Sabbagha R. Survival of a 280 gram infant. (Correspondence) N Eng J Med 1991; 324:1598-1599.

Muraskas J, Hasson A, Besinger RE. Long Term Follow-Up of a 280 Gram Infant. Correspondence. N Engl J Med 2004; 351(8):836-37.

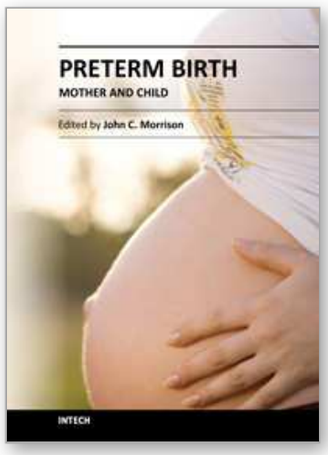
Rhoden NK. Treating Baby Doe: The Ethic of Uncertainty. Hastings Center Report, August 1986, pp. 34-42.

Singh J, Fanroff J, Andrews B, Caldarelli L, Lagatta J, Plesha-Troyke S, Lantos J, Meadow W. Resuscitation in the "Gray Zone" of Viability: Determining Physician Preferences and Predicting Infant Outcomes. Pediatrics 2007; 120:519-526.

Stephens BE, Tucker R, Vohr BR. Special Health Care Needs of Infants Born at the Limits of Viability. Pediatrics 2010; 125:1152-1158.

University of Iowa, The Tiniest Babies Registry. http://www.medicine.uiowa.edu/tiniestbabies/index.htm

Weiss MG, Muraskas JK, eds. Loyola University of Chicago Stritch School of Medicine Neonatal Intensive Care Unit Resident Physician Manual. 2009.



Preterm Birth - Mother and Child

Edited by Dr. John Morrison

ISBN 978-953-307-828-1
Hard cover, 368 pages
Publisher InTech
Published online 27, January, 2012
Published in print edition January, 2012

While there are many studies and books regarding preterm birth, both the obstetric and in the neonatal/pediatric literature, what is missing is the integration of data from obstetrics through neonatal course and into pediatrics as the neonate transverses childhood. A continued dialogue between specialties is essential in the battle against preterm birth in an attempt to relieve the effects or after-effects of preterm birth. For all of our medical advances to date, preterm birth is still all too common, and its ramifications are significant for hospitals, families and society in general.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Jonathan Muraskas, Lisa DeGregoris, Colleen Rusciolelli and Christine Sajous (2012). Preterm Birth of Extremely Low Birth Weight Infants, Preterm Birth - Mother and Child, Dr. John Morrison (Ed.), ISBN: 978-953-307-828-1, InTech, Available from: http://www.intechopen.com/books/preterm-birth-mother-and-child/preterm-birth-of-extremely-low-birth-weight-infants

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

IntechOpen