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Care of the Very Low–birthweight Infant

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In Brief

Increasing survival among extremely preterm infants has focused more attention on these babies, who are smaller in birthweight and lower in gestational age. Technological and therapeutic advances have improved during the past 2 decades, increasing survival among the smallest, most immature infants, some as young as 22 to 23 weeks’ gestation. Successful resuscitation and stabilization of the extremely preterm infant requires clinicians trained in delivery room preparation and management as well as immediate newborn care needs of such infants. Particular attention must be paid to the prevention of hypothermia, maintenance of glucose homeostasis, and provision of appropriate nutrition support, as well as the prevention of lung injury, retinopathy of prematurity (ROP), and infection.

Once alerted that a preterm baby will be born, a member of the neonatal team should meet with the expectant family. The scope of the prenatal consultation depends on the maternal medical and pregnancy-related conditions, associated fetal risks or prenatally diagnosed fetal abnormalities, and the urgency of the impending delivery. The resuscitation area should be checked to ensure that all necessary equipment is available. The infant warmer should be turned on and prewarmed blankets and a polyethylene bag made available. The room temperature should be adjusted to reduce any stress in the infant due to cold.

Routine resuscitation equipment includes suction equipment, laryngoscope and the appropriately size endotracheal tubes, umbilical vessel catheterization supplies, and resuscitation medications. Some delivery services have available a T-piece resuscitator, which allows for controlled continuous positive airway pressure or positive-pressure ventilation (PPV) as part of the resuscitation and stabilization. The suction and laryngoscope should be checked to ensure proper functioning. Blended oxygen capable of delivering 21% to 100% oxygen and a pulse oximeter also should be readily available.

To decrease the risk for intraventricular hemorrhage and brain injury during resuscitation, the baby always should be handled gently and not placed in a head down or Trendelenburg position. Fluid boluses, if necessary, should be administered over 5 to 10 minutes to avoid rapid fluctuations in blood pressure. If PPV is required, excessive pressure should be avoided. Pulse oximetry to monitor heart rate and oxygen saturation (SpO₂), along with arterial blood gas analysis, can minimize episodes of hyperoxia and hypocarbia. Hypocarbia occurs during periods of lung overdistension from excessive ventilation and contributes to lung injury and cerebral ischemia. The SpO₂ often remains in the 80s during the first 10 minutes after birth. The fraction of supplemental inspired oxygen should be lowered as soon as there is a clinical response and SpO₂ is in the target range of 85% to 95%. Research is in progress to determine if room air might be the best agent to use in newborn resuscitation.

Great care should be taken to maintain a thermoneutral state for the child. Core body temperature decreases rapidly from heat loss after delivery. Hypothermia is associated strongly with ad-
verse outcomes, so maintaining a body temperature of 97.7°F to 98.6°F (36.5°C to 37.0°C) is the goal. Heat loss can be minimized by keeping the delivery room at 77.0°F to 80.6°F (25.0°C to 27.0°C), placing the infant on a radiant warmer, wrapping the infant in prewarmed blankets, and placing the baby in a polyethylene bag immediately after delivery before drying. The infant should be transported to the neonatal unit (NICU) in a heated transport isolette.

Assigning Apgar scores to a very low-birthweight infant (VLBW) infant can be difficult. Tone and reflexes are diminished in the preterm baby compared with the term infant. Heart rate, respiratory rate, and color are interrelated and affected by the infant’s clinical status. With the inherent differences in the VLBW infant’s neurologic status, it may be difficult for the baby to achieve an Apgar score greater than 6.

After initial stabilization, a thermoneutral environment must be maintained. On admission to the NICU, VLBW infants typically are cared for on radiant warmers or in heated, servo-controlled isolettes. A skin temperature probe permits continuous monitoring of the infant’s temperature, with automatic adjustment of the heat output to maintain the temperature between 97.7°F and 98.6°F (36.5°C and 37.0°C). If the infant remains hypothermic, warmed bags of saline or additional warming lamps may be used.

Initial assessment of the infant includes measurement of blood glucose. With low endogenous glycogen and fat stores and a relatively limited capacity for gluconeogenesis, the preterm neonate requires a continuous infusion of glucose to prevent hypoglycemia. The initial glucose requirement typically is in the range of 4 to 6 mg/kg per minute, provided as a 10% dextrose solution infused at a rate of 80 to 120 mL/kg per day. Serum glucose measurements should be followed carefully, initially on an hourly basis until stable and then every 3 to 4 hours during the critical stage of illness. Blood glucose concentrations for neonates should be greater than 50 mg/dL (2.8 mmol/L) in the first 24 hours after birth and greater than 50 to 60 mg/dL (2.8 to 3.3 mmol/L) thereafter.

At 1 week after birth, total fluid infusion rates for VLBW infants are in the range of 130 to 170 mL/kg per day. Glucose infusion rates of approximately 8 mg/kg per minute typically provide adequate carbohydrate nutrition while maintaining appropriate blood glucose concentrations in the baby who is not being fed enterally. Glucose infusion rates greater than 12 to 13 mg/kg per minute should be avoided because of adverse respiratory and metabolic consequences. Some VLBW infants develop hyperglycemia on lower glucose infusion rates and require lower concentrations of dextrose (7.5% or 5%).

Poorly keratinized skin and immature renal concentrating ability lead to a net loss of water. Although electrolyte measurement and supplementation are not needed immediately after birth, serum chemistry measurements must be followed closely. The frequency of blood sampling depends on the size and stability of the infant, with the smallest babies requiring measurements up to every 6 hours and larger, more stable infants requiring measurements only every 12 to 24 hours. Because dehydration can occur rapidly in the VLBW infant, daily weight measurement is necessary.

Weight loss in the range of 8% to 10% in the first postnatal week is common, although some extremely preterm infants may lose up to 15% of their birthweight. Weight loss in excess of 2% to 3% per day in conjunction with an increased serum sodium concentration indicates worsening dehydration. Total free water requirements increase as gestational age decreases. Avoiding excessive fluid administration, however, is prudent to avert fluid overload, abnormal blood chemistry, persistent patency of the ductus arteriosus, and an increased risk of chronic lung disease.

Use of humidification in isolettes is an effective method of reducing transcutaneous water loss and decreasing free water requirements. To facilitate fluid management, blood sampling, and blood pressure monitoring, umbilical venous and arterial catheters may be placed. Alternatively, a percutaneously inserted central catheter may be inserted if long-term intravenous access is needed.

Appropriate nutrition support for the very preterm infant is critical. VLBW infants develop significant protein deficits rapidly during the first postnatal week and are at risk for protein malnutrition. Parenteral nutrition support should be initiated on admission to the NICU to provide the infant with at least 1.5 g/kg per day of amino acids and 40 kcal/kg from carbohydrate and fat. Recent studies have demonstrated the efficacy and safety of administering 3 g/kg per day of amino acids from the day of birth.

The early initiation of enteral feedings with human milk has been shown to improve survival by promoting intestinal growth and maturation, reducing the risk for late-onset sepsis and necrotizing enterocolitis (NEC), and improving neurodevelopmental outcome. An early goal of nutrition support is for the infant to regain birthweight by 10 to 14 days and to achieve full enteral feedings by 2 to 4 weeks of age. In addition, human milk for preterm infants requires nutrient fortification to prevent macronutrient and mineral deficiencies that contribute to suboptimal extrauterine growth and poor bone mineralization (osteopenia). Extrauterine growth failure is common among VLBW infants, with approximately 75% of babies born weighing less than 1,000 g (2.2 lb) achieving weights at
less than the 10th percentile at 36 weeks postmenstrual age.

Feeding intolerance, slow transit time, and susceptibility to injury predispose the preterm infant to developing NEC, even with preventive strategies such as early exclusive human milk and small-volume (trophic) feedings. Infants who develop NEC are at risk for intestinal perforation and its sequelae, which include short bowel syndrome, significant nutritional deficiencies, and growth failure. The need for prolonged parenteral nutrition support and for medications such as diuretics predispose the infants to additional complications, including cholestasis, gallstones, nephrolithiasis, osteopenia (rickets) of prematurity, and anemia caused by iron and vitamin E deficiency. Maximizing caloric intake by fortification of human milk and careful monitoring of growth can help mitigate the growth failure commonly seen in VLBW infants.

Careful attention must be paid to the infant’s respiratory status after birth. Respiratory distress syndrome (RDS) caused by lung immaturity and surfactant deficiency is common and increases in frequency as gestational age decreases. Respiratory management with supplemental oxygen to maintain PaO₂ values between 50 and 70 mm Hg (oxygen saturation 85% to 95%), early nasal continuous positive airway pressure, and intubation with surfactant administration and mechanical ventilation, when appropriate, are essential. Avoidance of hyperoxia is critical in the prevention of ROP. Infants less than 30 weeks’ gestation who have RDS benefit from surfactant replacement therapy administered prophylactically in the delivery room or as rescue therapy within 4 hours of birth. Any VLBW infant who has RDS requiring intubation should be given surfactant as soon as possible.

Maternal infection (urinary tract infection, chorioamnionitis, bacterial vaginosis) is a common trigger for preterm labor and delivery. Consequently, unless a clear noninfectious cause for the preterm delivery (placenta previa accompanied by hemorrhage or pre-eclampsia) is found, the infant should be evaluated for infection and treated with antibiotics until test results are available. Administration of antibiotics to the mother prior to delivery is appropriate but may complicate assessment of the infant’s sepsis risk. However, appropriate intrapartum antibiotic treatment of the mother should not be deferred because of this concern.

Evaluation of the neonate should include a complete blood count and blood culture. C-reactive protein measurements can aid in the initial assessment of the infant who is suspected of having sepsis. Unless neurologic signs suggest meningitis or the blood culture is positive, some clinicians defer obtaining a lumbar puncture during the initial evaluation of the VLBW infant.

Broad-spectrum antibiotic therapy is initiated to treat the more common neonatal pathogens: group B Streptococcus, Listeria monocytogenes, and gram-negative bacteria such as Escherichia coli. VLBW infants born to mothers who received antibiotics have a greater risk of infection with gram-negative organisms. Ampicillin and gentamicin offer broad-spectrum treatment for these common neonatal pathogens and are the first-line antibiotics typically administered to the infant. Neonatal herpes infection should be suspected in infants who exhibit vesicular rash, thrombocytopenia, or seizures. Herpes polymerase chain reaction testing and surface and cerebrospinal fluid cultures should be obtained and acyclovir therapy initiated for presumptive herpes infection.

Complications associated with preterm birth can affect all aspects of the preterm child’s health and development. The consequences of lung immaturity compounded by the effects of respiratory therapies can lead to the development of chronic lung disease of infancy, specifically bronchopulmonary dysplasia (BPD). Some infants require prolonged (home) oxygen therapy. Complications such as a pneumothorax, pulmonary hemorrhage, or blood pressure instability predispose preterm infants to intraventricular hemorrhage (IVH), white matter injury caused by brain ischemia, and cerebral atrophy (ventriculomegaly).

The degree of prematurity correlates most strongly with developmental outcomes. Neuroimaging studies (cranial ultrasonography or magnetic resonance imaging) to detect the presence of hemorrhage, white matter injury (periventricular leukomalacia), or ventriculomegaly provide additional information and can assist the clinician in discussing the child’s long-term prognosis with the family. Approximately 15% to 20% of VLBW infants develop an intracranial hemorrhage.

Infants who have Grade I IVH (subependymal or periventricular hemorrhage) do not have a significantly increased risk, but a grade II hemorrhage (bleeding into the ventricular system without associated ventricular dilatation) is associated with a small increase in the incidence of adverse neurodevelopment, particularly in relation to difficulties in academic achievement, memory, and executive function. Grade III IVH (bleeding into the ventricular system with ventricular dilatation) leads to neurodevelopmental impairment in approximately 30% of affected children. In contrast, up to 90% of infants who have a grade IV hemorrhage (intraventricular and intraparenchymal bleeding) experience neurocognitive or motor impairment.

Periodic neurodevelopmental assessment is necessary through school age to determine an individual child’s functional abilities and developmental needs. Early identification of developmental delays and referral for early
intervention services is an important component of the infant’s postdischarge care. Factors associated with the highest risk for an adverse neurodevelopmental outcome are male sex, gestational age younger than 28 weeks, BPD, cerebral white matter injury, late-onset sepsis or NEC, and the need for surgery. In addition, infants who have persistent poor weight gain or head growth (<10%) after 36 weeks’ postmenstrual age are at high risk for poor outcome (cerebral palsy, intelligence quotient <70).

Convalescent care of the VLBW infant as he or she approaches readiness for NICU discharge involves treating a series of other complicating problems, such as anemia of prematurity, apnea of prematurity, BPD, poor feeding skills, gastroesophageal reflux disease, and ROP. Many infants need to remain in the hospital until their expected due date, although many go home 1 month or more earlier. Discharge depends on physical maturity, as evidenced by adequate feeding and temperature and glucose stability, as well as by cardiorespiratory stability with the absence of apnea for a reasonable period of time. These babies need long-term follow-up care by clinicians familiar with the particular needs of VLBW infants. Parents need extensive education and support throughout the NICU stay and beyond to ensure that their children have an environment that promotes achievement of their maximum potential. Despite numerous obstacles, most of these children thrive and lead satisfying, successful lives.

Comment: Not too long ago, commenting on Dr DeWayne Pursley’s article about the development of preterm infants (Pediatr Rev. 2008;29:67–68), I wrote that the rise in the rate of preterm births in the United States is alarming. Allow me to repeat myself. National statistics demonstrate a consistent increase in the preterm birth rate, with a peak at 12.7% (1 in 8 babies) in 2005, the last year for which data are complete. From 1981 to 2005, the rate rose by 35%. In 2005, 500,000 infants were born preterm, with 80,000 of them at less than 32 weeks’ gestation. The rate of prematurity for African American infants was 18.4%. The progress we have made in the treatment of VLBW infants, as described by Dr Angert, is nothing short of miraculous, but for pediatricians dedicated foremost to prevention, the statistics must be distressing in the human cost they reflect, not to mention the financial cost. The Institute of Medicine has estimated the bill for prematurity and its consequences to be $26 billion per year.

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Editor, In Brief