· Standard/Protocol/Guideline ·

Management guidelines of premature infants

The Subspecialty Group of Neonatology, Pediatric Society, Chinese Medical Association

Abstract: Objective Prematurity is one of the leading causes of death and disability in neonates. To improve the management of premature infants, the Subspecialty Group of Neonatology, Pediatric Society, Chinese Medical Association established the guideline on the 7th National Neonatal Academic Conference in October 2004. The guideline makes references to management at birth, respiration management, prevention and treatment of cerebral injury of premature infants, prevention and treatment of infection, maintenance of stable blood glucose, nutritional management, management of feeding intolerance, fluid balance, management of patent ducts arteriosus (PDA), prevention and treatment of anemia, treatment of jaundice of prematurity, prevention and treatment of retinopathy of prematurity (ROP), hearing screening, nursing and follow-up following discharge. [**Chin J Contemp Pediatr, 2005, 7(1):1-7**]

Key words: Case management; Infant, premature

早产儿管理指南

中华医学会儿科学分会新生儿学组

[**摘　要**] 早产是新生儿发病和围产儿死亡最常见的因素,为提高早产儿的管理水平,降低病死率和致残率,新生儿学组经过 2 年多的讨论,于 2004 年 10 月第七届全国新生儿学术会议(海口)通过本指南,供各单位参考。本指南就早产儿出生时处理,呼吸管理,脑损伤的防治,感染的防治,保持血糖稳定,营养支持,消化问题的处理,液体平衡,动脉导管开放,贫血的防治,黄疸的治疗,早产儿视网膜病的防治,听力筛查,护理,出院后的随访等 15 个问题制定了具体的管理方案。 [**中国当代儿科杂志,2005, 7(1):1-7**]

[**关　键　词**] 疾病管理;婴儿,早产
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Infants who are born before 37 weeks of gestation are defined as premature infants. Among them, those with birth weights of less than 1 500 g are defined as very low birth weight (VLBW) infants; those with birth weights of less than 1 000 g are defined as extremely low birth weight (ELBW) infants. Among premature infants, those born ≤ 32 weeks or with birth weights < 1 500 g have greater morbidity and mortality. To improve on this, a thorough understanding of issues pertaining to proper treatment and management of this fragile group is imperative. Premature infants comprise such a large group in neonatology, therefore the Subspecialty Group of Neonatology institutes the *Management Guidelines of Premature Infants* after over 2 years' discussion, to provide references for hospitals in China.

Management at birth

History acquaintance

If time allows prior to the delivery of a premature infant, neonatologists should obtain a detailed history regarding the state of mother-and-fetus, ascertain any contributors to premature delivery and anticipate possible problems that may occur during delivery.

Resuscitation

The incidence of asphyxia is high in premature infants, so the most current practices for neonatal resuscitation should be administered after birth in a timely but gentle fashion. State of the whole body should be carefully estimated during resuscitation.

Maintenance of thermoneutrality

Attention should be paid to maintaining a warm environment for the premature infant after birth. Energy expenditure by the newborn is minimized by maintenance of a thermoneutral environment. The thermoneutral temperature is the environmental temperature, which minimizes energy expenditure by the infant for maintenance of a stable body temperature. To this end, temperature of the delivery room should be maintained at 27-28℃, and humidity at 60%-70%. Quickly dry the infants, put them in the prehea-

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ted cotton blanket, then in the preheated incubators. As the infant's body surface area to mass ratio is very large which facilitates heat expenditure, minimizing the time that the infant is naked should be a priority. Once in an incubator, the temperature should be set at approximately 33-35℃ maintain thermoneutrality according to the birth weight and postnatal age of the infant (Table 1). The relative humidity of the incubator should be 70%-80% or higher at 80%-90% for ELBW infant. All operations should be done in the incubator in order to keep the temperature constant. Infants should also be kept warm when temporarily out of the incubators.

Table 1 Neutral temperature of premature infants (incubator)

Birth weight (kg)	Incubator temperature			
	35 ℃	34 ℃	33 ℃	32 ℃
1.0	<10 days	10 days	3 weeks	5 weeks
1.5	—	<10 days	10 days	4 weeks
2.0	—	< 2 days	2 days	3 weeks

Respiration management

Oxygen inhalation by head net or nasal catheter

Oxygen inhalation (always by head net) should be delivered to the infants whose blood oxygen saturation is lower than 88%. It is optimal to use head net with air/oxygen mixed gas resource. The total flow is 4-6 L/minutes. Concentration of inhaled oxygen should be regulated according to percutaneous oxygen saturation (SpO_2) or arterial blood gas analysis. For older infants, oxygen can be inhaled by nasal catheter, and flows of 0.5-1.0 L/minutes. The concentration of oxygen inhaled should be strictly controlled, in order to maintain the SpO_2 between an ideal range of 88%-94%.

Continuous positive airway pressure (CPAP) ventilation

Infants with mild or early-stage neonatal respiratory distress syndrome (NRDS), transient tachypnea of newborn (TTN), apnea or infectious pneumonia can be treat with nasal CPAP. Physiologic PEEP of 2-3 cm H_2O is often ineffective in these disease states at preventing atelectasis at end expiration but re-expansion may be achieved by CPAP of 4-6 cm H_2O. The concentration of inhaled oxygen should be as low as possible. Proper use of CPAP can reduce the use of mechanical ventilation.

Mechanical ventilation

In some patients despite early use of CPAP, $PaCO_2$ may continue to rise with a concomitant fall in PaO_2. At such time, infants will often require institution of mechanical ventilation. Commonly, conventional mechanical ventilation (CMV) is employed to begin with but if inadequate oxygenation or hypercarbia remain a concern, conversion to high frequency ventilation (HFV) may be necessary. HFV reduces $PaCO_2$ levels more effectively than CMV therefore careful blood gas monitoring is essential to prevent severe hypocarbia especially after switching from CMV. As well, mean airway pressure (MAP) is distributed more effectively with HFV than CMV therefore early X-ray assessment is required to recognize hyperinflation of the lungs. In this circumstance if MAP is not reduced this may lead to low cardiac output states secondary to reduced preload.

Surfactants replacement

Pulmonary surfactants (PS) therapy is indicated in infants with suspected NRDS, who have dyspnea or grunting respirations. For those infants placed on early CPAP, consideration of surfactant therapy should also be given if FiO_2 requirement exceeds 40%. Surfactant works best when given early in the disease process therefore do not wait until the X-ray results show typical NRDS changes as much time may have elapsed by the time an X-ray is done. The single dosage is 100 mg/kg. Second and third doses may be administered 10-12 hours later if the concentration of inhaled oxygen is >0.4 or the mean airway pressure is >0.78 kPa (8 cm H_2O). PS has two forms: powder and suspension, both of which need cryopreservation. The powder must be resuspended by shaking with normal saline, while the suspension must be thawed then shaken, which can be done by preheating in the incubator. Before administration of PS, the infant should be well suctioned and intubated. Prophylactic PS is administered as a single 100 mg/kg dose to the infants with gestational ages < 28 weeks or birth weights < 1 000 g after resuscitation.

Prevention and management of apnea

Monitoring Including monitoring of apparatus, close observation by the doctors and nurses. The patient's head should be positioned in the midline and the neck kept in a natural pose so as to reduce upper airway obstruction.

Tactile stimulation Many apneas are short lived and an infant will recover on their own without intervention. However for the apnea persisting beyond 15 to 20 seconds or if accompanied by cyanosis or bradycardia intervention may be required. Rubbing the back or flicking the sole of foot may provide enough stimulation to resolve the apnea. For those infants who do not respond to these measures free flow oxygen may be provided. If further desaturation or bradycardia occurs bag-and-mask ventilation may be adopted.

Medication 1) Aminophylline: Loading dose: 4-6 mg/kg, IV; maintenance dose: 2 mg/kg per time, 2-3 times daily. Maintain the blood concentration at 5-15μg/mL. Due to the short half-life of aminophylline, frequent administration is needed. Side effects such as restlessness, tachycardia, convulsion, gastrointestinal hemorrhage, feeding intolerance, polyuria, dehydration and hyperglycemia may occure. 2) Caffeine citrate: Loading dose: 20 mg/kg (equal to 10 mg/kg caffeine), IV; maintenance dose: 5 mg/kg 24 hours later, once daily. Maintain the blood concentration at 10-20

μg/mL. Caffeine citrate has a long half-life, few side effects and high liposolubility, so it can penetrate the blood-brain barrier rapidly. The domestic preparation has sodium benzoate caffeine, which can displace bilirubin from albumin therefore it should not be used in infants with jaundice. 3) Naloxone: Dosage: 0.1 mg/kg, IV. Repeated 4-6 hours later if necessary. It is indicated in infants whose mothers have used dolantin (4-6 hours) before delivery. Its use is contraindicated in infants born to mothers who are addicted to drug, as the infant will have a high risk of seizures.

Other treatments Nasal CPAP ventilation can be used when frequently occlusive or mixed apnea appears. Mechanical ventilation is required if apnea is still frequent. High ventilator parameters are generally unnecessary. For secondary apnea, treatment of the primary disease will often improve the apneas.

Prevention and treatment of bronchopulmonary dysplasia (BPD)

Respiration supporting Infants with severe BPD may be ventilator or CPAP dependent. Oxygenation should be achieved using the smallest MAP and oxygen concentration possible to prevent further barotrauma and oxidative injury. Furthermore attempts should be made to extubate these infants to CPAP or nasal canulae as soon as possible. Use of permissive hypercapnea with pCO_2 levels of 55 - 65 cmH_2O or for the chronic patient with metabolic alkalosis even higher levels may facilitate earlier extubation. Whatever level of pCO_2 is chosen the arterial pH should remain above 7.25.

Fluids control Lungs with BPD have excess fluid therefore restriction of fluid intake to 120-140 mL/kg per day may be required. Unfortunately such restriction may be complicated by inadequate weight gain due to undernourishment thus higher fluid intakes may be necessary along with the institution of diuretics, such as hydrochlorothiazide, antisterone or furosemide (100-120 mL/kg). Careful monitoring of electrolytes is required as sodium and potassium balance may become quite disturbed.

Glucocorticosteroid Glucocorticosteroids have anti-inflammatory properties, but have significant neurological side effects, so their use should be restricted to only those with the most severe forms of BPD. Routes of administration include IV or inhalational. Airway spray administration is optimal.

Anti-infection Infants with BPD may develop ventilator-associated pneumonias. Historically mycoplasmas such as Ureaplasma Urealyticum were linked to exacerbation of BPD but recent evidence has refuted this belief. In many centers this infection is no longer treated, however for suspected pneumonia with new localized infiltrates on chest X-ray antibiotic treatment may be indicated. In these cases a sputum culture should be performed and antibiotics chosen according to the results of susceptibility test.

Nutrition support Enough caloric (100-120 kcal /kg per day) should be given. Trace elements and vitamins should be supplied in time.

Prevention and treatment of cerebral injury of premature infants

Intracranial hemorrhage

Strategies to prevent intracranial hemorrhage include avoidance of hypotension, acidemia, hypothermia, excessive volume or infusion of hyperosmolar solutions. A quiet environment with minimal handling may also be of benefit. Routinely, 1mg Vit K_1 (IV) is provided to prevent hemorrhagic disease of the newborn. Neuroimaging allows diagnosis of intracranial hemorrhage of the premature infant. Most often hemorrhages are intraventricular and can be diagnosed readily by ultrasound, but CT may be required to diagnose bleeding in other locations in the intracranial vault. The infant whose weight is < 1 500 g should be given bedside transcranial sonography on the 3rd, 7th and 30th day after birth, in order to be diagnosed at an early stage. The follow-up visit should be done periodically, and the cranial CT scan can be done when necessary.

Periventricular leukomalacia (PVL)

PVL is related to such factors as prematurity, hypoxia-ischemia, mechanical ventilation, low $PaCO_2$, hypotension and infection. It occurs most commonly, in the VLBW or ELBW infants particularily those between 28-32 weeks gestation. Infants below 28 weeks while not prone to the development of PVL more often develop other white matter changes and global cerebral atrophy. PVL may present clinically as suppression, low reaction and decreased muscular tone, or even brain paralysis in severe patients. The infant whose weight is <1 500 g should be evaluated by ultrasound between 6 weeks after birth to detect most cases of PVL. The transcranial CT scan or MRI can be done when necessary.

Prophylaxis for PVL is very important, for there is no effective therapy yet. It is very clear that chorioamnionitis is a strong predictor of PVL therefore in mothers with suspected chorioamnionitis delivery should be expedited. The transcranial sonography and behavioral neurological assessment should be examined periodically in the infants with PVL.

Prevention and treatment of infection

Prophylaxis is the main method to deal with infection. The sterilization and isolation rules should be obeyed strictly. Handling of infants should be minimized. Wash hands seriously and reduce invasive operations. If infection is suspected, appropriate investigations including blood culture, C-reactive protein (CRP), blood routine examination, and arterial blood gas analysis should be performed. A lumbar puncture (LP) should also be performed in any infant with a strong suspicion of sepsis as it may be more difficult to di-

agnose meningitis if antibiotics are given prior to the LP. Regarding CRP, its utility as a test may be improved by waiting 12 hours after the initial work-up, as it typically does not rise until many hours after the onset of sepsis. With respect to urine culture, if a septic work-up is being performed in the first 48 hours of life this test may be eliminated, as the urinary tract will be sterile before this time. If a blood culture is found to be positive, antibiotics should be selected according to the pathogen characteristics and susceptibility test results. By 48 hours if a blood culture is negative there is a high likelihood that it will remain negative therefore consideration should be given to discontinuing antibiotics at that time. For seriously infected infants, IVIG or refrigerated plasma can be used. The morbidity of antepartum infection is relatively high in premature infants. The goal should be to diagnose and treat these infections in a rapid fashion.

Maintenance of stable blood glucose

Hypoglycemia

Blood glucose of < 2.2 mmol /L (40 mg/dL) is defined as hypoglycemia, regardless of gestational age and birth weight. The blood glucose of premature infants should be monitored conventionally, 3-4 times a day, until the blood glucose is stable.

Repeat onsets of hypoglycemia can induce cerebral injury, which should be prevented and treated actively. 1) Early feeding: Those at risk of hypoglycemia should be fed with 5% glucose at 1 hour after birth and begin to be fed milk at 2-3 hours after birth. 2) Intravenous drip of glucose: The infant whose blood glucose is <2.2 mmol /L (40 mg/dL) despite having an early feed should be given 10% glucose 2 mL/kg bolus followed by an infusion of 6-8 mg/kg per minutes, IV. Even without symptoms, the infant whose blood glucose is lower than 1.6 mmol/L (30 mg/dL) should be given 10% glucose 2 mL/kg bolus followed by an infusion of 8-10 mg/kg per minutes (IV) to maintain the blood glucose within normal range. Repeated and refractory hypoglycemia should be investigated and the primary cause should be treated.

Hyperglycemia

Blood glucose of >7 mmol/L(125 mg/dL) is defined as hyperglycemia. The main causes include infusion of high concentrations of IV glucose or at too rapid an infusion, stress hyperglycemia or drug-induced hyperglycemia. Infants may manifest positive urine sugar and osmotic diuresis. Some will even have dehydration, which is high osmotic dehydration, and manifest irritability without obvious dehydration.

Prevention and treatment

Blood glucose monitoring The blood glucose should be monitored several day] s after birth. The quantity and speed of the dripped glucose should be adjusted according to the blood glucose.

Controlling the drip speed of the glucose Use 5% glucose as diluent.

Using insulin Insulin can be indicated, if the blood glucose continues to be higher than 15 mmol/L (270 mg/dL). The dosage of insulin should begin at 0.01 U/kg per hour, maintained by intravenous dripping. The blood glucose levels should be followed up carefully and the dosage of insulin should be adjusted according to the blood glucose.

Nutritional management

Nutrition requiremens

1) Give 40 kcal /(kg · d) the first day after birth, and increase by 15 kcal /(kg · d) to 100-120 kcal /(kg · d). 2) The amount of lipid, sugar and protein is distributed according to proportion. 3) Supply vitamins and trace elements at the same time.

Feeding method

Nursing or bottle-feeding It is optimal for those premature infants who have a good suckling and swallowing mechanism. Even for those infants who are not yet able to feed by this route, the bottle or nipple should be offered to avoid the development of feeding aversion. This can usually be tried as early as 32 weeks gestation with the goal being to allow the infant to grow accustomed to the nipple in the mouth.

Gavage feeding It is fit for those who have disharmonized suckling and swallowing mechanism. It includes intermittent gastric canal method and continual gastric canal method. For those who suffer severe asphyxia, intestinal feeding should be delayed (Table 2).

Table 2 Enteral feeding protocol of premature infants

	<1 000		1 000-1 499 g		1 500-2 000 g		>2 000 g	
	Volume/time	Interval	Volume/time	Interval	Volume/time	Interval	Volume/time	Interval
Initial feeding	1-2 mL/kg	1-2 hrs	2-3 mL/kg	2 hrs	3-4 mL/kg	2-3 hrs	10 mL/kg	3 hrs
Early feeding 12-72 hrs	increasing 1 mL every other time up to 5 mL	2 hrs	increasing 1 mL every other time up to 10 mL	2 hrs	increasing 2 mL every other time up to 15 mL	2-3 hrs	increasing 5 mL every other time up to 20 mL	3 hrs
Subsequent feeding >72 hrs	10-15 mL	2 hrs	20-28 mL	2-3 hrs	28-37 mL	3 hrs	37-50 mL	3-4 hrs

Choice of formula

Breast milk is better for premature infants with respect to immunological, nutritional and physiological aspects. For VLBW and ELBW infants, their growth rate will be slow if they are fed with breast milk without breast milk fortifier. For those who cannot be fed with breast milk, formula milk for premature infants can be used and it is designed according to the physiological aspects of premature infants. Once an infant has reached full enteral feeds, if weight gain is less than 15-20 g/(kg · d), growth may be enhanced by increasing the concentration of formula to 0.78-0.85 kcal/g.

Parenteral nutrition

The tolerance of intestinal feeding of younger premature infants is worse than that of the older ones. Parenteral nutrition is used as a supplement to enteral feeding. Lipids and amino acids can be started at a rate of 0.5 g/(kg · d) and increased by increment of 0.5 g/(kg · d), the maximum dosage is often 2-3 g/(kg · d).

Management of feeding intolerance

Prevention and treatment of gastroesophageal reflux

Gastroesophageal reflux (GER) is a common problem in premature infants. The incidence increases with decreasing gestational age and body weight. Aspiration of gastric contents may follow GER and lead to pneumonitis or pneumonia, which may require initiation of positive predictive value (PPV). Diagnosis depends on obtaining a good history of the event, and is supplemented by isotope image or 24-hour ambulatory esophageal pH monitoring. The main treatment options include: 1) Body position: Keep the infant upright at a thirty degree angle, lie on the right side. 2) Medications: Erythromycin, motilium or cimetidine can be used.

Prevention and treatment of necrotizing enterocolitis (NEC)

NEC is predominantly a disorder of premature infants, Any infant with suspected NEC should be managed according to the following protocol: 1) Those with possible NEC should remain NPO (non per os; nothing by mouth) for 1-2 days. Feeding should be reinstituted slowly and the abdomen monitored closely for distension and tenderness. For the infant with proven NEC and mild symptoms, they should be placed NPO for 3-5 days, and those with severe NEC 7-10 days. Other therapy should include gastrointestinal decompression by nasogastric suction and parenteral nutrition to maintain basal nutrition and fluids needs during the fast. Feedings should not be restarted until the absence of abdominal distention, bilious emesis and bloody stools has been confirmed. Fresh breast milk is recommended, but formula milk for premature infants can also be used. Only a small amount of milk should be fed at the beginning, then the amount increased gradually. The patient should be placed NPO if the symptoms should resume. It may take some time before full enteral feeds are tolerated and the physician should be prepared to reduce the volume of feeding on several occasions due to the development of feeding intolerance. 2) Prevention and treatment of infection: Empiric antibiotics include the third generation cephalosporins and metronidazole if there is portal air or pneumoperitoneum present. 3) Improvement of circulation: Shock often occurs in the NEC infant. This is frequently caused by infection, hypovolemia or multiple organ dysfunction, and should be treated with correcting volume deficit and using dopamine and dobutamine. 4) Correction of the water electrolyte disturbance: Fluid, electrolyte and acid-base disorders must be corrected. 5) Surgical treatment: perforation of intestine and severe necrosis of intestine required surgical operation to resect the part of necrosis and perforation. Abdominal symptoms and signs and serial X-ray studies should be closely observed; pediatric surgeons should be closely contacted; the development of the stage of illness should be closely assessed.

Fluid balance

Fluid volume required in the first postnatal day is 50-60 mL/kg, and may be increased by 20 mL/kg per day up to 150 mL/kg. If the infant's weight loss exceeds 2% - 5% per day or whenever the weight loss exceeds 10% -15%, an increase of fluids is required.

Management of patent ductus arteriosus (PDA)

Who to treat

Most preterm infants will have a visible ductus arteriosus on echoencephalogram (ECHO) in the first few days of life as it begins to close. Infants <30 weeks have ductuses that are more likely to remain open if they become symptomatic (active precordium, hepatomegaly, bounding pulses, murmur, increased work of breathing) and therefore consideration should be given to medical closure of these ducts if the infant is symptomatic. For the older infant ≥ 30 weeks, treatment may be deferred if the infant remains asymptomatic as the ductus will likely close on its own.

Fluid restriction

Infused fluid is commonly 20 mL/kg per day less than that would be appropriate for an infant of the same age without a clinical ductus arteriosus.

Indomethacin

For the infant 0-7 days, the first dose is 0.2 mg/kg, the second and third doses are 0.1 mg/kg at an interval of 12 and 24 hours per dose. For the infant is >7 days, the second and third dose is also 0.2 mg/kg. Commonly, intravenous drip, oral intake or clysis is applied.

Ibuprofen

The dose used is an initial dose of 10 mg/kg followed by 2 doses of 5 mg/kg each after 24 and 48 hours. Intravenous drip is adopted. Compared with indomethacin, ibuprofen has fewer side effects.

Surgery treatment

Surgery should be performed in patients with a hemodynamically significant PDA in whom after 2 courses of medication treatment the cardiopulmonary function remains severely affected.

Prevention and treatment of anemia

Anemia in premature infants usually occurs 2-3 weeks after birth, severe anemia can impair growth and development therefore we should take strategies to prevent it.

Minimizing iatrogenic blood loss

Many blood sampling tests are required for the premature infants. The amount of blood drawn should be minimized and volumes recorded. The mini-blood test and percutaneous test should be promoted.

Recombinant human erythropoietin (EPO)

EPO can be used in severe cases, 250 IU/kg given 3 times per week subcutaneously or intravenously for 4-6 weeks. The need for transfusions can be reduced but not be avoided with EPO use.

Other medication treatment

Vitamin E, 10 mg/day given orally in 2 divided doses at the same time using EPO. Element iron, 2 mg/(kg · d) given orally in 2 divided doses beginning 1 week later, and increased by 2 mg/(kg · d) up to 6 mg/(kg · d).

Blood transfusion

Blood transfusion is required if the hemoglobin level is < 80-90 g/L and the following instances occur: gestational age < 30 weeks; respiration frequency > 50 times/minute when calm; heart rate > 160 times/minute; it is easy to be tired when takes food; weight increase < 25 g / day; blood lactate > 1.8 mmol/L. The amount of blood transfusion is 10-15 mL/kg per time.

Treatment of jaundice of prematurity

Prevention and treatment of the early stage jaundice

Preterm infants are at greater risk of neurologic impairment from hyperbilirubinemia because they metabolize bilirubin slower than their term counterparts. In addition, their blood-brain barrier is not as mature; their serum albumin level is low and they are more prone to anoxia, acidosis, and infection which may increase permeability of the blood brain barrier. Treatment such as phototherapy or exchange transfusion should be decided according to gestational age, birth weight and total bilirubin level at various postnatal age (Table 3).

Table 3 Recommendatory protocol for premature infants with jaundice

(Totol serum bilirubin, μmol/L)

Gestational age/ Birth weight	< 24 hrs		24-48 hrs		48-72 hrs	
	Phototherapy	Exchange transfusion	Phototherapy	Exchange transfusion	Phototherapy	Exchange transfusion
< 28 weeks/ < 1 000 g	17-86	86-120	86-120	120-154	≥120	154-171
28-31 weeks/1 000-1 499 g	17-103	86-154	103-154	137-222	≥154	188-257
32-34 weeks/1 500-1 999 g	17-103	86-171	103-171	171-257	171-205	257-291
35-36 weeks/2 000-2 499 g	17-120	86-188	120-205	205-291	205-239	274-308

Prevention and treatment of cholestasis syndrome of prematurity

Because of premature delivery, parenteral feeding and infection, cholestasis syndrome frequently occurs in young premature infants, and obstructive jaundice occuring from 3-4 weeks after birth. The measures for prevention and treatment of the syndrome include: giving enteral feeding whenever possible; reducing the quantity and duration of parenteral nutrition; preventing infection; and administering orally or intravenously cholagogue of traditional Chinese medicine.

Prevention and treatment of retinopathy of prematurity (ROP)

The morbidity of ROP in premature infants is high, because of incomplete vascularization of the retina at birth. Hypoxic stress leads to changes in the retina, which may in the worst case lead to retinal detachment and blindness. It is urgent to reinforce prophylaxis, early diagnose and treatment of ROP and reduce the morbidity and sequelae of ROP.

Prevention and treatment of the complications

Strategies to minimize the use of oxygen while ventilated should be employed with particular attention paid to avoiding wide changes in PO_2.

Appropriate use of oxygen

The concentration of oxygen and the duration of inhalation should be strictly controlled. Goal SpO_2 should be 88%-94%.

Screening

Screening is essential for the early diagnosis of ROP, which should be carried out by experienced oculist. 1)

Screening objects: Premature infants whose birth weight are < 2 000 g or gestational age are < 34 weeks, no matter whether they have inhaled oxygen, especially the infants whose birth weight are < 1 750 g or corrected gestational age are < 32 weeks, and the infants with serious complications, or who had inhaled high concentration oxygen for a long time. 2) Screening time: Four weeks after birth or 32 weeks of gestational age. 3) Screening method: Fundus oculi examination by indirect ophthalmoscope or fundus digital camera.

Follow-up and treatment

Schedule of follow-up visits is decided by the results of the first examination (Table 4).

Table 4 Fundus oculi changes and managements of ROP

Fundus oculi changes	Managements
Without ROP	1 follow-up every 2 weeks, till 42 weeks of corrected gestational age
Stage Ⅰ	1 follow-up every 2 week, till ROP vanishment
Stage Ⅱ	1 follow-up every week, till ROP vanishment
Pre-stage Ⅲ	2-3 follow-ups every week
Stage Ⅲ	Laser or congealed therapy within 72 hrs
Stage Ⅳ	Vitrectomy, Cerclage of sclera
Stage Ⅴ	Vitrectomy

Hearing screening

Many complications such as anoxia, jaundice, acidosis, hypocapnia and infection will occur in premature infants, who need mechanical ventilation and admission in NICU for a long time. And these are precipitating factors of hearing impairment. So, hearing screening by Otoacoustic Emissions (OAEs) is needed for premature infants, which is performed on the 3rd and the 30th day of their life. If the screening was not passed, test of brain stem evoked potential should be carried out in order to make an early diagnosis and treatment.

Nursing

Special nursing care is required for premature infants. Special attentions should be paid to the following instances: 1) Keep a comfortable environment. The lamplight should be gentle; the incubator should be covered with small dark coverlet so as to reduce light stimulation; and noise should also be avoided. 2) Reduce outside stimulations. Dispensable operations should be avoided whenever possible; and the indispensable operations should be carried out intensively. 3) Stress asepsis principle. All apparatuses used should be strictly disinfected; and all operations for premature infants should be performed in disinfection. 4) Observe and record the patients' conditions carefully. 5) Closely monitor SpO_2, heart rate, respiration, blood pressure, blood gas analysis, and electrolytes. 6) Some positive measures of development nursing should also be carried out for premature infants so as to improve development and reduce the incidence of sequelae. These measures include skin-touching, passive gymnastics and vision and audition stimulations.

Follow-up following discharge

Follow-up visits must be performed for the discharged premature infants, with a frequency of once per 1-2 months in the first half of the year, once per 2-3 months in the later half of the first year and once per half year afterward. Neurodevelopment as an important marker of follow-up may be evaluated by behavior tests, transcranial sonography or CT scans, and electroencephalogram. If any problem occurs during the follow-up, the infant should be sent in time to corresponding sections to accept interventions.

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