

[Newborn Care Manual: Contents](#)

## JAUNDICE

### 24-1 WHAT IS JAUNDICE?

Jaundice is the yellow colour of the skin and sclerae caused by deposits of bilirubin. In newborn infants the sclerae (white of the eye) are difficult to see and, therefore, the skin colour is used to detect jaundice. Jaundice is a clinical sign and not a laboratory measurement.

<b>NEONATAL JAUNDICE IS A YELLOW COLOUR OF THE SKIN CAUSED BY BILIRUBIN</b>
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### 24-2 WHAT IS BILIRUBIN?

Red blood cells contain a red pigment called haemoglobin which carries oxygen. Red cells in the fetus and newborn infant live for 3 months only. Therefore, the body is continually forming new red cells in the bone marrow and destroying old red cells in the liver and spleen.

Haemoglobin in the red cells is broken down into a yellow pigment called bilirubin. This unconjugated bilirubin is carried by albumin in the blood stream to the liver where it is first conjugated (joined to another substance) and then excreted in the bile. If the concentration of bilirubin in the serum (blood) rises, it becomes visible in the skin causing jaundice. Newborn infants normally have a high haemoglobin concentration and, therefore, produce a lot of bilirubin.

<b>NORMAL NEWBORN INFANTS PRODUCE A LOT OF BILIRUBIN</b>
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### 24-3 WHAT IS HYPERBILIRUBINAEMIA?

Hyperbilirubinaemia is defined as a total serum concentration of bilirubin (TSB) that is higher than the normal range. Normally the bilirubin concentration in the serum is low at birth, less than 35  $\mu\text{mol/l}$ . It then climbs steadily for the first few days before returning again to an adult level of less than 35  $\mu\text{mol/l}$  by 2 weeks. The total serum bilirubin concentration in term infants usually does not rise above 200  $\mu\text{mol/l}$  (12 mg/dl).

The upper limit of the total serum bilirubin concentration (TSB) in most healthy term infants is approximately:

Days after birth:	0	0,5	1	2	3	4	5
TSB ( $\mu\text{mol/l}$ ):	35	75	125	150	175	200	200

*\*\*\* The upper limit of the normal bilirubin concentration is very controversial. In healthy, term, breast fed infants the upper limit may be as high as 275  $\mu\text{mol/l}$ .*

### 24-4 HOW IS BILIRUBIN MEASURED?

It is both difficult and inaccurate to assess the concentration of bilirubin in the serum by clinical examination of the degree of jaundice, especially in an infant with a dark skin. Therefore, it is important to measure the bilirubin concentration of the serum if an infant is jaundiced. Usually a sample of blood is collected into a capillary tube and spun down to separate the serum from the red cells. The total serum bilirubin (TSB) is then measured with a bilirubinometer and expressed in  $\mu\text{mol/l}$ . The TSB includes both unconjugated and conjugated bilirubin. However, in the newborn infant the TSB usually consists mainly of unconjugated bilirubin.

<b>THE TOTAL SERUM BILIRUBIN (TSB) CANNOT BE ESTIMATED ACCURATELY BY ASSESSING THE DEGREE OF JAUNDICE IN THE SKIN</b>
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The measurement of packed cell volume and total serum bilirubin is discussed in skills workshop 24 of this PEP manual.

**24-5 HOW IS BILIRUBIN EXCRETED IN THE ADULT?**

Unconjugated bilirubin, formed by the breakdown of red cells, is carried by albumin in the blood stream to the liver. In the liver cells enzymes combine the unconjugated bilirubin with glucuronic acid to form conjugated bilirubin. This chemical process, called conjugation, makes the bilirubin water soluble. Only when the bilirubin is water soluble can the liver cells excrete it into the small bile ducts. From here the conjugated bilirubin is carried in the bile to the intestine where it is further converted by bacteria into the brown pigment, stercobilin. In the adult, bilirubin is not reabsorbed from the intestine.

**CONJUGATION OF BILIRUBIN IN THE LIVER IS ESSENTIAL BEFORE IT CAN BE EXCRETED IN THE BILE**

**24-6 HOW IS BILIRUBIN EXCRETED IN THE FETUS?**

The fetus is unable to excrete conjugated bilirubin via the stool as it usually does not normally pass meconium and also lacks bacteria in the intestines to convert bilirubin into stercobilin. Fetal bilirubin, therefore, is excreted by the placenta into the mother's blood. However, the placenta can only remove fat soluble, unconjugated bilirubin and not water soluble, conjugated bilirubin. To ensure that most of the fetal bilirubin remains unconjugated, the enzyme system that controls bilirubin conjugation in the liver functions very slowly. The small amount of conjugated bilirubin that is excreted into the bile is carried to the fetal intestine. Here a special fetal enzyme deconjugates the bilirubin, which is then reabsorbed back into the fetal blood stream as unconjugated bilirubin.

**BILIRUBIN IN THE FETUS IS EXCRETED BY THE PLACENTA RATHER THAN THE LIVER**

**24-7 HOW IS BILIRUBIN EXCRETED IN THE NEWBORN INFANT?**

During the first week of life the enzyme system that conjugates bilirubin with glucuronic acid in the liver functions slowly, as in the fetus. Therefore, unconjugated bilirubin accumulates in the serum as the placenta is no longer present to remove it. As a result, newborn infants commonly become jaundiced due to an increased concentration of unconjugated bilirubin in the serum. After a few days the rate of liver conjugation increases and the bilirubin concentration in the serum slowly returns to the normal adult range of less than 35  $\mu\text{mol/l}$ . Jaundice at birth or in the first 24 hours is unusual, however, as the bilirubin is adequately excreted by the placenta up until the time of delivery.

Some of the bilirubin that is conjugated and excreted by the liver in the first week of life is often broken down by the fetal enzyme in the intestine which continues to function for a few weeks after birth. This unconjugated bilirubin is reabsorbed by the intestine adding to the increase of the TSB.

**JAUNDICE DURING THE FIRST 24 HOURS IS ALWAYS ABNORMAL**

\*\*\* *The reabsorption of bilirubin from the intestine back into the blood stream of newborn infants (enterohepatic circulation of bilirubin) is due to the enzyme  $\beta$  glucuronidase in the bowel wall. This enzyme is also present in breast milk resulting in a higher TSB in breastfed infants. Some breastfed infants also remain jaundiced for more than two weeks (breast milk jaundice).*

**24-8 WHAT ARE THE CAUSES OF JAUNDICE?**

The main causes of jaundice in the newborn infant are:

1. Increased production of bilirubin.
2. Slow bilirubin conjugation in the liver.
3. Decreased excretion of bile.

**24-9 WHAT ARE THE CAUSES OF AN INCREASED PRODUCTION OF BILIRUBIN?**

There are many causes of an increased bilirubin production:

1. The normal newborn infants produces a lot of bilirubin due to a high haemoglobin concentration.
2. CEPHALHAEMATOMA or BRUISING. Haemoglobin which has escaped out of the blood vessels is rapidly broken down into bilirubin which is absorbed into the blood stream.
2. POLYCYTHAEMIA. Infants with a very high packed cell volume or haemoglobin concentration have excess haemoglobin and, therefore, produce a lot more bilirubin than normal.
3. INFECTION. General infections such as septicaemia and syphilis cause haemolysis. The released haemoglobin is converted into bilirubin.
4. HAEMOLYTIC DISEASE OF THE NEWBORN. Excess haemolysis causes an increased level of unconjugated bilirubin.

\*\*\* *Excessive haemolysis may rarely be due to deficiency of a red cell enzyme (e.g. glucose 6 phosphate dehydrogenase deficiency), an abnormal red cell membrane (e.g. spherocytosis) or an abnormal haemoglobin (e.g. alpha thalassaemia).*

**24-10 WHAT ARE THE CAUSES OF SLOW BILIRUBIN CONJUGATION?**

1. Normal, healthy, term infants have a slow bilirubin conjugation for the first week after delivery. The liver of the newborn infant during the first few days of life, therefore, functions like that of the fetus.
2. About 10% of clinically healthy, term infants have a TSB that increases above the normal range. They have a greater than usual delay in the maturation of their liver enzymes responsible for conjugation.
3. Preterm infants also commonly have a TSB that rises above the normal range due to immaturity of their liver enzymes. This is known as JAUNDICE OF IMMATURITY. Jaundice is commoner in preterm than in term infants.
4. CONGENITAL HYPOTHYROIDISM due to the absence of a thyroid gland in the infant may cause prolonged jaundice due to slow maturation of the liver enzymes. Although rare, it is important as these children become severely mentally retarded if not diagnosed and treated soon after birth. They need lifelong thyroxine treatment.

In all these conditions, with an increased production or slow conjugation of bilirubin, the serum bilirubin is unconjugated.

**PROLONGED JAUNDICE MAY BE DUE TO HYPOTHYROIDISM**

**24-11 WHAT CAUSES A DECREASED EXCRETION OF BILIRUBIN?**

1. Healthy breast fed infants have a decreased excretion of bilirubin for a few weeks as they reabsorb some unconjugated bilirubin from the intestine back into the blood stream. This is commonly present in breastfed infants. The raised TSB is due to unconjugated bilirubin.
2. HEPATITIS due to septicaemia, viral infection or syphilis. Swelling of the liver cells obstructs the flow of bile in the small bile ducts.
3. BILIARY ATRESIA is destruction of the bile ducts caused by a viral infection during the first weeks of life.

Diseases of the liver (hepatitis and biliary atresia) prevent the excretion of conjugated bilirubin into the bile. Conjugated bilirubin is, therefore, reabsorbed into the blood stream, resulting in jaundice. This is called obstructive jaundice, and can be diagnosed by finding a high concentration of CONJUGATED bilirubin in the serum. If bilirubin cannot be excreted in the bile, the stools become pale. Some of the excess conjugated bilirubin is excreted by the kidneys, giving dark urine. Jaundice due to decreased excretion of bilirubin is far less common in newborn infants than jaundice due to the excessive production or decreased conjugation of bilirubin.

**PALE STOOLS AND DARK URINE SUGGEST THAT THE JAUNDICE IS DUE TO LIVER DISEASE**

### 24-12 WHAT IS PHYSIOLOGICAL JAUNDICE?

All healthy newborn infants have a total serum bilirubin concentration (TSB) higher than in adults. This is due to the normal increase in production, slow conjugation and decreased excretion of bilirubin. As a result, 50% of normal, term infants have mild jaundice during the first two weeks of life. However, they are clinically well, their jaundice disappears by two weeks and their TSB does not rise above 200  $\mu\text{mol/l}$  (12 mg/dl). This is known as PHYSIOLOGICAL JAUNDICE. Mild jaundice is, therefore, very common in normal infants.

**MILD JAUNDICE IN HEALTHY INFANTS IS VERY COMMON IN THE FIRST TWO WEEKS OF LIFE**

*\*\*\* Some studies suggest that in physiological jaundice the TSB may rise as high as 275  $\mu\text{mol/l}$ .*

### 24-13 WHAT IS HAEMOLYTIC DISEASE OF THE NEWBORN?

Haemolytic disease of the newborn is the condition where antibodies (immunoglobulins) from the mother cross the placenta into the fetal blood stream. Here these antibodies destroy the fetal red cells (haemolysis) causing anaemia and an increased production of bilirubin in the fetus and newborn infant.

The 2 most important causes of haemolytic disease of the newborn are:

1. ABO haemolytic disease.
2. Rhesus haemolytic disease.

### 24-14 WHAT ARE BLOOD GROUPS?

Red cells contain proteins on their surface called antigens, which determine a person's blood group. A fetus's red cell antigens are inherited from both parents and, therefore, may differ from that of the mother. The most important red cell antigens are the ABO antigens and the D (Rhesus) antigen. If the A antigen is present on a person's red cells the blood group will be A. Similarly, the presence of B antigen makes the blood group B. If both antigens are present the blood group will be AB while if both antigens are absent the blood group will be O. Most people are blood group O.

The D antigen is inherited separately from the ABO antigens. The presence of the D antigen on the red cells makes a person Rhesus positive (Rh positive). If the D antigen is missing, then the person is Rhesus negative (Rh-ve).

Therefore, a person with A and D antigens will have the A+ blood group while another with neither A,B nor D will be blood group O -ve.

### 24-15 WHAT IS ABO HAEMOLYTIC DISEASE?

ABO haemolytic disease occurs when the mother is blood group O and her fetus is blood group A or B. The fetus having inherited these blood groups from the father. For reasons unknown, some group O mothers start producing anti-A or anti-B antibodies which cross the placenta and cause fetal haemolysis by attacking the fetal red cells. The haemolysis is not severe enough to damage the fetus but may cause severe jaundice in the newborn infant. ABO haemolytic disease may occur in a first pregnancy or any later pregnancy.

The maternal antibodies, which stick to the fetal red cells, give a POSITIVE COOMB'S TEST in the newborn infant, while the haemolysis results in a low packed cell volume and haemoglobin, and a raised TSB. An infant with ABO haemolytic disease usually appears normal at delivery, as the placenta has been able to remove the excess bilirubin produced during pregnancy. However, the infant becomes jaundiced within the first 24 hours after birth. The TSB may increase rapidly and reach dangerous levels. Due to the haemolysis, the infant becomes anaemic. Unfortunately ABO haemolytic disease is not preventable nor can it be diagnosed accurately before delivery. ABO haemolytic disease is the commonest cause of severe jaundice in term infants.

**ABO HAEMOLYTIC DISEASE IS THE COMMONEST CAUSE OF SEVERE JAUNDICE  
IN TERM INFANTS**

\*\*\* In ABO haemolytic disease the mother produces IgG antibodies to A or B. These antibodies can cross the placenta and, therefore, differ from the IgM to A and B which are present in the serum of all group O adults.

#### 24-16 HOW DO YOU DIAGNOSE ABO HAEMOLYTIC DISEASE AT BIRTH?

1. The mother is blood group O.
2. The father is blood group A, B or AB.
3. The infant is blood group A or B.
4. The Coomb's test is positive in the infant.
5. The TSB is often high (above 35  $\mu\text{mol/l}$ ) while the haemoglobin and packed cell volume is often low (below 45%) in the cord blood.
6. The infant commonly develops jaundice within 24 hours of delivery. The jaundice usually increases rapidly and the TSB may reach dangerous levels during the first week.
7. The TSB at 6 hours after delivery is often above 80  $\mu\text{mol/l}$ .

#### JAUNDICE ON DAY 1 SUGGESTS HAEMOLYTIC DISEASE

#### 24-17 WHAT IS RHESUS HAEMOLYTIC DISEASE?

Rhesus haemolytic disease is haemolytic disease of the newborn caused by maternal antibodies to the D antigen. With Rhesus haemolytic disease, the mother is always Rhesus negative (Rh negative or Rh -ve) while the fetus and infant are always Rhesus positive (Rh positive or Rh +ve).

Normally the fetal red blood cells do not enter the maternal circulation during pregnancy or delivery. However, if the fetal capillaries in the placenta are damaged, fetal red blood cells may cross into the maternal blood. If the fetal red cells have the D antigen (Rh positive) but the mother's do not (Rh negative), then the fetal cells may be recognised by the mother's immune system as foreign. As a result the Rh negative mother will respond by producing antibodies (anti-D) against these foreign red cells. This process is known as SENSITIZATION. Rarely an Rh negative woman may also be sensitized against the D antigen if she receives an incompatible blood transfusion with Rh positive red cells.

Rhesus haemolytic disease is more severe than ABO haemolytic disease. Rhesus haemolytic disease is rare in first pregnancies as it only occurs if fetal blood crosses the placenta (a fetomaternal bleed) to reach the mother's blood and, thereby, sensitizes her into producing anti-D antibodies. Rhesus haemolytic disease becomes progressively worse with each further pregnancy. Unlike ABO haemolytic disease, with Rhesus haemolytic disease the degree of fetal haemolysis is severe and the fetus may go into heart failure with resulting generalised oedema (called hydrops) due to anaemia and die. Fortunately Rhesus haemolytic disease is not common, because most people are Rh positive. Rhesus haemolytic disease can be prevented.

\*\*\* The Rhesus blood group is named after the Rhesus monkey used in early experiments with red cell antigens. Rhesus haemolytic disease can also be caused by other Rhesus antigens (C, c, E and e). These forms are less severe than Rhesus haemolytic disease due to the D antigen (Rh D haemolytic disease). Rarely, haemolytic disease of the newborn is caused by other blood groups.

Fetal red cells may cross the placenta into the mother's blood:

1. At delivery (the most common).
2. During a miscarriage.
3. With abruptio placentae.
4. During amniocentesis.
5. During external cephalic version.

#### THE FETUS CAN DIE OF RHESUS HAEMOLYTIC DISEASE

**24-18 HOW CAN YOU PREVENT RHESUS HAEMOLYTIC DISEASE?**

The Rh positive fetal red cells that cross the placenta can be destroyed before they sensitize the mother by giving her 100 µg (4 ml) anti-D immunoglobulin by intramuscular injection within 72 hours. This is usually given after delivery of an Rh negative mother. However, anti-D immunoglobulin must also be given after any of the above complications of pregnancy. Unfortunately it is useless giving the mother anti-D immunoglobulin if she has already been sensitized and has developed her own anti-D antibodies.

**GIVE ALL RHESUS NEGATIVE MOTHERS ANTI-D IMMUNOGLOBULIN AFTER DELIVERY****24-19 HOW CAN YOU DIAGNOSE RHESUS HAEMOLYTIC DISEASE DURING PREGNANCY?**

1. Mother's blood group is Rhesus negative.
2. Father's blood group is Rhesus positive.
3. Mother has anti-D antibodies in her blood.
4. Mother may have had a previous infant with jaundice or a past obstetric history which suggests a fetomaternal bleed. Usually the mother would not have received anti-D immunoglobulin after her previous deliveries.

The blood group of all pregnant women should be determined at the start of antenatal care. If you suspect that the pregnancy is complicated by Rhesus haemolytic disease (i.e. a Rh negative patient with anti-D antibodies), the mother must be referred urgently to a hospital where specialist care is available.

**ALL WOMEN MUST HAVE THEIR BLOOD GROUPS IDENTIFIED DURING PREGNANCY**

Rhesus haemolytic disease should be considered if the infant is jaundiced, pale and oedematous in the first 24 hours of life. Severe Rhesus haemolytic disease affecting the fetus can be diagnosed during pregnancy if antenatal ultrasound examination shows signs of fetal oedema and heart failure (hydrops fetalis).

**RHESUS HAEMOLYTIC DISEASE SHOULD BE DIAGNOSED DURING PREGNANCY****24-20 IS JAUNDICE DANGEROUS?**

Jaundice can become dangerous when the concentration of UNCONJUGATED bilirubin in the blood becomes very high. Unconjugated bilirubin may then enter the brain of the newborn infant and cause BILIRUBIN ENCEPHALOPATHY (kernicterus). CONJUGATED bilirubin is not toxic to the brain. In clinical practice the TSB is used to assess whether the bilirubin is reaching dangerous concentrations as the TSB in newborn infants usually consists almost entirely of unconjugated bilirubin.

The risk of bilirubin encephalopathy depends on:

1. The TOTAL SERUM BILIRUBIN concentration. The higher the TSB, the greater is the chance that unconjugated bilirubin will cross the blood brain barrier into the brain cells.
2. The GESTATIONAL AGE. The more preterm the infant the higher the risk due to an immature blood brain barrier.
3. The POSTNATAL AGE. A high TSB in the first few days has a greater chance of increasing to dangerous levels than the same TSB at a week of age.
4. Factors that may make the BLOOD BRAIN BARRIER MORE PERMEABLE TO BILIRUBIN, such as hypoxia, hypothermia, hypoglycaemia and infection.

\*\*\* *The blood brain barrier is a complex mechanism that prevents toxic substances like bilirubin crossing from the blood into the brain cells.*

In well, term infants the TSB becomes dangerous above 350 µmol/l (20 mg/dl) while in preterm infants the TSB becomes dangerous above 250 µmol/l (15 mg/dl). The dangerous level is lower if factors that make the blood brain barrier more permeable to bilirubin are also present.

**A HIGH SERUM CONCENTRATION OF UNCONJUGATED BILIRUBIN CAN DAMAGE THE BRAIN**

**24-21 HOW DO YOU RECOGNISE BILIRUBIN ENCEPHALOPATHY?**

1. The infant is very jaundiced.
2. The TSB is high.
3. At first the infant is lethargic, hypotonic, has a weak cry, poor Moro reflex and feeds poorly with vomiting due to depressed brain function.
4. Later the infant becomes irritable with a high pitched cry, jitteriness, opisthotonus and convulsions due to brain irritation.

Many infants with bilirubin encephalopathy die while the survivors are usually deaf and mentally retarded with hypotonic cerebral palsy. Every effort must, therefore, be made to prevent bilirubin encephalopathy.

**24-22 HOW CAN YOU PREVENT BILIRUBIN ENCEPHALOPATHY?**

By not allowing the TSB to reach dangerous levels. A number of methods can be used to reduce the TSB:

1. Give early milk feeds to reduce the amount of bilirubin that is reabsorbed from the intestine.
2. Prevent preterm delivery.
3. Give anti-D immunoglobulin to all Rhesus negative mothers after delivery, a miscarriage, amniocentesis, abruptio placentae or external cephalic version.
4. Give phototherapy when the TSB approaches dangerous levels.
5. Do an exchange transfusion when phototherapy cannot keep the TSB below dangerous levels or when dangerous levels have already been reached.

**EARLY MILK FEEDS HELP TO LOWER THE TOTAL SERUM BILIRUBIN****24-23 WHAT IS PHOTOTHERAPY?**

Phototherapy uses white or blue light to change unconjugated bilirubin in the skin into a water soluble form of bilirubin. The water soluble bilirubin is then carried by albumin in the blood to the liver, from where it can be excreted without having to be conjugated. Phototherapy is, therefore, able to lower the TSB. Bright light is able to change the shape but not the chemical composition of the bilirubin molecule. Ultraviolet light, which causes sunburn and severe tissue damage, could kill an infant and is not used for phototherapy.

*\*\*\* With phototherapy, unconjugated bilirubin is converted by the process of photoisomerization into photobilirubin and lumirubin which are water soluble and, therefore, easily excreted. Phototherapy does not conjugate bilirubin.*

**24-24 WHAT IS USED TO GIVE PHOTOTHERAPY?**

Phototherapy is usually given with a phototherapy unit which consists of a row of fluorescent tubes. Daylight tubes (SABS No. 5) or white tubes (SABS No. 2) are used. They should be changed after 1000 hours use as, despite still appearing bright, their effectiveness decreases with time. A perspex (clear plastic) sheet must be placed below the tubes to reduce heat and filter out any ultraviolet light. A perspex sheet also protects the infant if a fluorescent tube breaks or comes loose.

The use of a phototherapy unit is explained in skills workshop 24 of this PEP manual.

Although exposure to sunlight also lowers the TSB, an infant placed in the sun may rapidly become hyperthermic. Therefore, this form of phototherapy must be used with great caution, if at all.

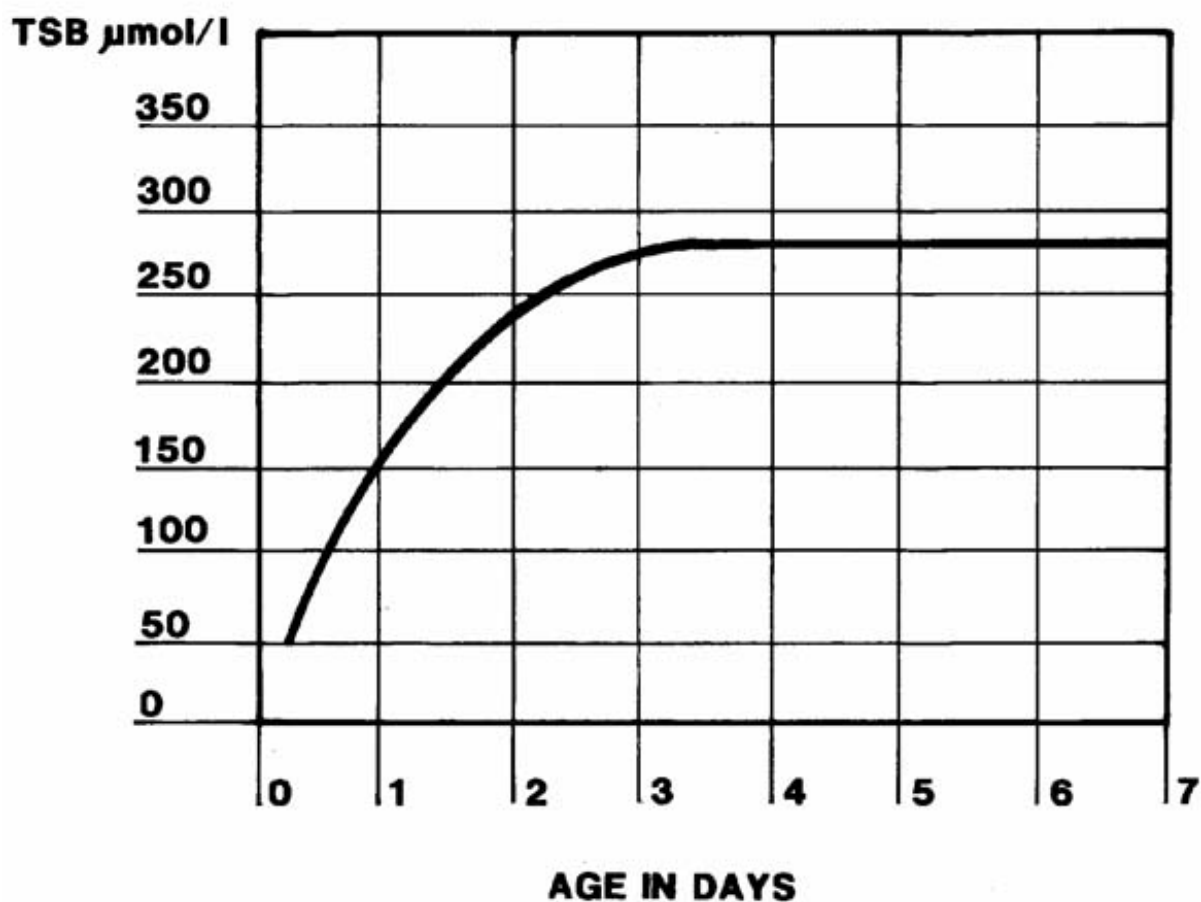
*\*\*\* The amount of light given out by the phototherapy unit can be measured with a photometer. Only light in the blue part of the spectrum is measured and the energy output is given in  $\mu\text{Watts}/\text{cm}^2/\text{nm}$ . An output above  $7\mu\text{Watts}$  is needed for effective phototherapy.*

**24-25 WHEN SHOULD YOU GIVE PHOTOTHERAPY?**

Whenever the TSB is above the normal range and approaches dangerous levels. In practice a simple chart is used to decide when to give phototherapy. If the TSB for the infant's age reaches the PHOTOTHERAPY LINE, treatment should be started. Phototherapy is usually started earlier in preterm or sick infants. Phototherapy should not be given to healthy, term infants who are jaundiced with a TSB below the phototherapy line.

All infants born to women who are blood group O should have their TSB measured at 6 hours after birth. If the TSB is above 80  $\mu\text{g/dl}$  phototherapy should be started.

Figure 24-1: Phototherapy guide showing the phototherapy line.



Guide for infants in different gestational age and weight categories is given in figure 24-2.

PROPHYLACTIC PHOTOTHERAPY is given when the TSB is still below the phototherapy line but either the TSB is expected to increase rapidly or the infant is at an increased risk of bilirubin encephalopathy. Therefore, prophylactic phototherapy is started immediately after birth if haemolytic disease of the newborn is suspected or diagnosed. Prophylactic phototherapy is usually started when the TSB reaches 125  $\mu\text{mol/l}$  in infants weighing less than 1250 g, at 150  $\mu\text{mol/l}$  in infants less than 1500 g, and at 200  $\mu\text{mol/l}$  in infants weighing less than 2000 g.

**24-26 HOW DO YOU GIVE PHOTOTHERAPY?**

1. Switch on the phototherapy unit and make sure the tubes are all working. Check the age of the tubes and ensure that the perspex sheet is in position.
2. Place the infant naked in an incubator or bassinet so that the mattress is about 40 cm from the phototherapy tubes. The infant must not wear a nappy. Instead, a nappy can be placed under the infant.
3. Cover the infant's eyes with pads as the bright light worries the infant and may possibly damage the retina. Remove the eye pads during feeding so that the eyes can be checked for infection and to allow the infant and mother to see each other.
4. Turn the infant over every hour. More frequent turning may make the phototherapy more effective.
5. Feed the infant milk, at least every 3 to 4 hours. Breast feed if possible. Add an extra 25 ml/kg/day if the infant is demand fed with formula. The lights may be switched off during feeds or the infant may be removed from the phototherapy unit when fed.
6. Monitor temperature hourly, weigh twice a day and measure TSB daily or more frequently if it approaches dangerous levels.
7. Allow the mother unrestricted visiting. If possible, the infant should be given phototherapy next to the mother in the postnatal ward.

**24-27 FOR HOW LONG SHOULD YOU GIVE PHOTOTHERAPY?**

Continue phototherapy until the TSB has been under the phototherapy line for 24 hours. Sometimes the TSB rises above the line again after the phototherapy has been stopped and treatment has to be restarted. However, once the TSB drops it usually stays down.

**24-28 WHAT ARE THE DANGERS OF PHOTOTHERAPY?**

1. The infant may become TOO HOT or TOO COLD. It is essential to monitor skin temperature very carefully during phototherapy.
2. The infant may pass loose green stools, due to the large amount of bilirubin excreted into the gut. The infant may also sweat more than usual. This may lead to EXCESSIVE WEIGHT LOSS due to dehydration. When under phototherapy, breast fed infants should be allowed to feed at least every 4 hours while bottle fed infants should receive an extra 25 ml/kg/day as milk feeds. There is no need to give extra clear feeds. All infants under phototherapy should have their weight monitored.
3. The infant's eyes should be covered with pads to prevent excessive exposure to bright light. The pads prevent the mother and infant seeing each other, however, and this may INTERFERE WITH BONDING. Conjunctivitis may also be hidden by the pads. Therefore, it is advisable to remove the eye pads every time the infant is fed. Replace the pads after the feed.
4. VISIBLE JAUNDICE RAPIDLY DISAPPEARS UNDER PHOTOTHERAPY EVEN IF THE TSB REMAINS HIGH or continues to increase. The TSB must be monitored in all infants receiving phototherapy.
5. Other CHANGES IN SKIN COLOUR may occur. After a few days the infant may become tanned. Erythema may result from excessive heat if a perspex sheet is not placed below the tubes. Most skin rashes are aggravated by phototherapy, and phototherapy given in error to an infant with conjugated hyperbilirubinaemia gives a grey/green colour to the skin known as bronzing.
6. Phototherapy SEPARATES THE INFANT FROM THE MOTHER and, therefore, should not be given unless there is a good reason. The separation caused by phototherapy results in maternal anxiety and also may prevent the establishment of breast feeding.

**THE TOTAL SERUM BILIRUBIN SHOULD BE MEASURED IN ALL INFANTS RECEIVING PHOTOTHERAPY**

**24-29 CAN PHENOBARBITONE BE USED TO TREAT JAUNDICE?**

There is little evidence that giving oral or intramuscular phenobarbitone adds to the effectiveness of phototherapy. It may also cause lethargy and poor feeding. Phenobarbitone is, therefore, not recommended to treat neonatal jaundice. It should not be used instead of phototherapy.

**\*\* Phenobarbitone 5 mg/kg intravenously may help lower the TSB in infants with severe jaundice. Clearing the meconium from the colon with a glycerine suppository may also help. In infants with Rh or ABO haemolytic jaundice, ??? of immunoglobulin intravenously stops the haemolysis.**

<b>ROUTINE USE OF PHENOBARBITONE TO REDUCE JAUNDICE IS NOT ADVISED</b>
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### 24-30 WHEN IS AN EXCHANGE TRANSFUSION NEEDED?

Except for infants with severe Rhesus haemolytic disease, an exchange transfusion is rarely needed today if phototherapy is used correctly when indicated. However, an exchange transfusion may still be needed if there is a delay in starting phototherapy and the progressive increase in TSB cannot be controlled.

The indications for an exchange transfusion are:

1. A TSB above 400  $\mu\text{mol/l}$  (20 mg/dl) in well term infants.
2. A TSB above 250 to 350  $\mu\text{mol/l}$  (15 mg/dl) in well preterm infants depending on the weight of the infant. The smaller the infant the lower the TSB at which an exchange transfusion is indicated.
3. A lower TSB if the infant is or has been hypoxic, hypothermic, hypoglycaemic or infected.
4. A rapidly rising TSB and falling packed cell volume on day 1 in an infant with Rhesus haemolytic disease.

**\*\*\* The following weight categories are a useful guide to the need for an exchange transfusion:**

	< 1500 g	1500-1999 g	2000-2499 g	> 2500 g
<i>Well infant</i>	250 $\mu\text{mol/l}$	300 $\mu\text{mol/l}$	350 $\mu\text{mol/l}$	400 $\mu\text{mol/l}$
<i>Sick infant or infant with haemolysis</i>	200 $\mu\text{mol/l}$	250 $\mu\text{mol/l}$	300 $\mu\text{mol/l}$	350 $\mu\text{mol/l}$

All infants who may need an exchange transfusion must be transferred urgently to a hospital with the staff and equipment needed. Send parental consent and a tube of clotted maternal blood with the infant. Give phototherapy in the meantime. Remember that an exchange transfusion has its dangers and side effects.

**\*\*\* In an exchange transfusion, twice the infant's blood volume is exchanged with fresh compatible group O negative donor blood (160 ml/kg). Usually the exchange is done via a catheter placed in the umbilical vein and 10-20 ml blood is exchanged at a time. Care should be taken to keep the infant warm and to monitor vital signs during the procedure.**

## ANAEMIA

### 24-31 WHAT IS ANAEMIA?

To determine whether an infant has anaemia, either of the following can be measured:

1. Packed cell volume (PCV), which is expressed as a percentage.
2. Haemoglobin concentration (Hb), which is expressed in g/dl.

Anaemia is defined as a PCV or Hb that falls below the normal range for the postnatal age of the infant.

The normal PCV at birth is 45 - 65% and the Hb 15 - 25 g/dl.

After delivery the PCV and Hb in term infants falls steadily until about 8 weeks of age and then slowly increases to about 35% and 12 g/dl respectively. The life span of the red cell in the infant is only 90 days compared to 120 days in the adult.

It is important that the PCV or Hb is measured on a sample of venous or arterial blood, or blood collected from a warm heel. Capillary blood sampled from a cold heel will give a falsely high reading.

#### **24-32 WHAT ARE THE COMMON CAUSES OF ANAEMIA IN THE INFANT?**

1. Anaemia of prematurity.
2. Repeated removal of small volumes of blood for special investigations (e.g. blood gasses).
3. Haemolytic disease of the newborn.
4. Haemorrhage before delivery (fetomaternal haemorrhage).
5. Haemorrhage at or after delivery (e.g. bleeding from the umbilical cord).
6. Infection (e.g. septicaemia and syphilis).

Iron deficiency does not cause anaemia in the newborn period. However iron deficiency anaemia is common after 3 months of age especially in preterm infants who do not receive regular iron supplements.

#### **24-33 WHAT IS ANAEMIA OF PREMATURITY?**

The PCV and Hb of the preterm infant are normal at birth but fall faster and to a lower level than those in the term infant. The more preterm the infant and the more blood is taken for investigations, the faster and lower will be the fall in PCV and HB. In most preterm infants the PCV falls to 30% and the Hb to 10 g/dl. Falls below these levels are common, especially in very preterm infants.

*\*\*\* The cause of anaemia of prematurity is failure of the immature kidney to secrete erythropoietin when the PCV and Hb fall below the normal range. As a result the bone marrow is not stimulated and does not release red cells into the blood stream.*

#### **24-34 WHEN SHOULD YOU TREAT ANAEMIA IN THE NEWBORN INFANT?**

Packed cells should be transfused into the infant if the PCV or Hb is below 45% and 15 g/dl respectively at birth or during the first 24 hours. Thereafter, term infants are usually transfused at a PCV below 30% or a Hb below 10 g/dl.

Packed cells should be given to an infant with anaemia of prematurity if the PCV falls below 25% or the Hb below 8,5 g/dl. An earlier transfusion is indicated if the PCV is 25-30% or the Hb 8,5-10 g/dl and the infant develops respiratory distress, signs of heart failure or patent ductus arteriosus, fails to grow or has severe infection.

The packed cells must be fully cross matched with the infant. Usually 10 ml/kg are given over 4 hours. Very small infants may need a number of transfusions during the first few months of life before their PCV and Hb returns to normal spontaneously. The PCV should be checked a week after the transfusion.

### **POLYCYTHAEMIA**

#### **24-35 WHAT IS POLYCYTHAEMIA?**

Polycythaemia (too much blood) is defined as a packed cell volume above 65% or a haemoglobin concentration above 25 g/dl. It is important that the blood is venous, arterial, or capillary blood from a warm foot. If the foot is cold and the blood has to be squeezed out, then the PCV and Hb will be falsely high.

Polycythaemic infants appear very red (plethoric). Usually polycythaemia causes no major problems although the infant may become jaundiced. However if the PCV and Hb are very high, the blood becomes thick and sticky causing neurological signs, respiratory distress, hypoglycaemia and heart failure.

**24-36 WHAT ARE THE CAUSES OF POLYCYTHAEMIA?**

1. Chronic fetal hypoxia:
  - (i) Underweight for gestational age infants.
  - (ii) Wasted infants.
2. Maternal diabetes.
3. Overtransfusion:
  - (i) Transfusion of blood from one identical twin to the other before delivery via a monochorionic placenta (twin-to-twin transfusion).
  - (ii) Accidental overtransfusion with blood after delivery. This can occur if the cord is not clamped and the infant is held at a level below the mother (placenta).

**24-37 WHAT IS THE TREATMENT OF POLYCYTHAEMIA?**

If the polycythaemia causes no clinical problem it does not need to be treated. During the first few weeks the PCV and Hb gradually return to normal. However, if the infant has neurological signs, respiratory distress, hypoglycaemia or heart failure due to the polycythaemia, then it must be treated by partial plasma exchange transfusion. The method is the same as an exchange transfusion for jaundice except that the infant is given normal saline, fresh frozen plasma or stabilized human serum. The exchange is limited to 20 ml/kg.

**CASE PROBLEMS****CASE 1.**

A well, breast fed, term infant develops jaundice on day 3 and the TSB (total serum bilirubin) is 120  $\mu\text{mol/l}$ . Both the mother and infant are blood group O+ve. The infant's packed cell volume is 60% (haemoglobin 20 g/dl) and the Coomb's test is negative.

**1. What is the probable cause of this infant's jaundice?**

This infant probably has physiological jaundice caused by the normally high bilirubin production, slow bilirubin conjugation by the liver and increased bilirubin reabsorption by the intestines.

**2. Why does the infant not have jaundice caused by ABO or Rhesus haemolytic disease?**

Because both the mother and infant have the same ABO and Rhesus blood groups, the infant's Coomb's test is negative, and the PCV (Hb) is normal. With haemolytic disease, the TSB would probably be much higher.

**3. Does this infant have hyperbilirubinaemia? Give reasons for your answer.**

No, this infant does not have hyperbilirubinaemia because the TSB falls within the normal range for day 3.

**4. What is the correct management of this infant?**

The infant should be managed as for a healthy, normal infant except that the TSB should be repeated daily until it starts to fall.

**5. Should this infant receive phototherapy?**

No. There is no reason for phototherapy.

**6. Should the mother stop breast feeding? Explain your answer.**

No. she should continue to breast feed. Although breast feeding may result in a slightly higher TSB, it is not necessary to stop breast feeding.

**CASE 2.**

An infant scores at 32 weeks and weighs 1600 g at birth. The infant has bilateral cephalhaematomas and becomes jaundiced on day 2 with a TSB of 190  $\mu\text{mol/l}$ . No treatment is given. On day 5 the infant becomes lethargic and hypotonic with a weak cry. The TSB is now 370  $\mu\text{mol/l}$ .

**1. Why do you think this infant became jaundiced?**

Because the infant is born preterm and has an immature liver with slow conjugation of bilirubin. In addition there is an increased production of bilirubin by the breakdown of haemoglobin in the cephalhaematomas.

**2. How should this infant have been treated on day 2?**

Phototherapy should have been started as soon as the TSB was above the phototherapy line.

**3. Why should you be worried if a jaundiced infant becomes lethargic and hypotonic with a weak cry?**

Because these are early signs of bilirubin encephalopathy. Remember that they may also be early signs of other problems such as septicaemia.

**4. How would you treat this infant's hyperbilirubinaemia?**

The TSB is so high that the infant must be given an exchange transfusion as soon as possible. In the meantime, phototherapy must be started. Do not drain the cephalhaematomas.

**CASE 3.**

A term infant becomes jaundiced at 12 hours. The mother is blood group O +ve and the infant is blood group B+. Phototherapy is started and after 24 hours the infant no longer appears jaundiced.

**1. What is the likely cause of this infant's jaundice?**

Haemolytic disease as the jaundice was noticed within the first 24 hours. The blood groups suggest ABO haemolytic disease. A positive Coomb's test would confirm the diagnosis of haemolytic disease.

**2. What investigation is needed before further management can be planned?**

The infant's TSB must be measured.

**3. Do you think that the phototherapy can be stopped safely on day 2 as the jaundice cleared? Explain your answer.**

No. Phototherapy may clear the jaundice although the TSB remains high.

#### 4. When should the phototherapy be stopped?

When the TSB has been below the phototherapy line for 24 hours. Thereafter, the TSB should still be monitored for a few days as the TSB may increase again due to continuing haemolysis.

#### CASE 4.

A preterm infant who weighed 1200 g at birth is now a month old. For the past week the infant has not gained weight but otherwise appears to be well. The PCV is 22%. The infant is being treated with iron supplements. As the infant now weighs 1800 g, the mother wants to take him home.

##### 1. Does this infant have anaemia?

Yes, because the PCV is below 30%.

##### 2. What is your diagnosis?

Anaemia of prematurity. Many preterm infants fail to produce red cells for a few weeks after birth.

##### 3. How should this infant be treated?

The infant needs a transfusion with packed cells. Normally, 10 ml/kg of blood is given over 4 hours.

##### 4. Why should this infant not be taken home yet?

Because the PCV (and Hb) may still continue to fall. Once the infant has been transfused he can be discharged. He should be brought back to the clinic or hospital to have his PCV checked after a week.

##### 5. Should this infant receive iron supplements?

Yes. Iron supplements will help to prevent iron deficiency in a few months time. However, Iron supplements will not prevent or correct the anaemia of prematurity.

#### CASE 5.

A term infant is born at home and then taken to the nearest hospital. On examination the infant appears well but is noted to be very plethoric. A capillary sample of blood is taken. The PCV is 70%.

##### 1. What is the diagnosis?

The infant has polycythaemia. This is suggested clinically by the red colour and confirmed by the high PCV.

##### 2. What is a normal PCV at birth?

At birth the normal PCV is 45 to 65%. During the first few weeks the PCV gradually drops.

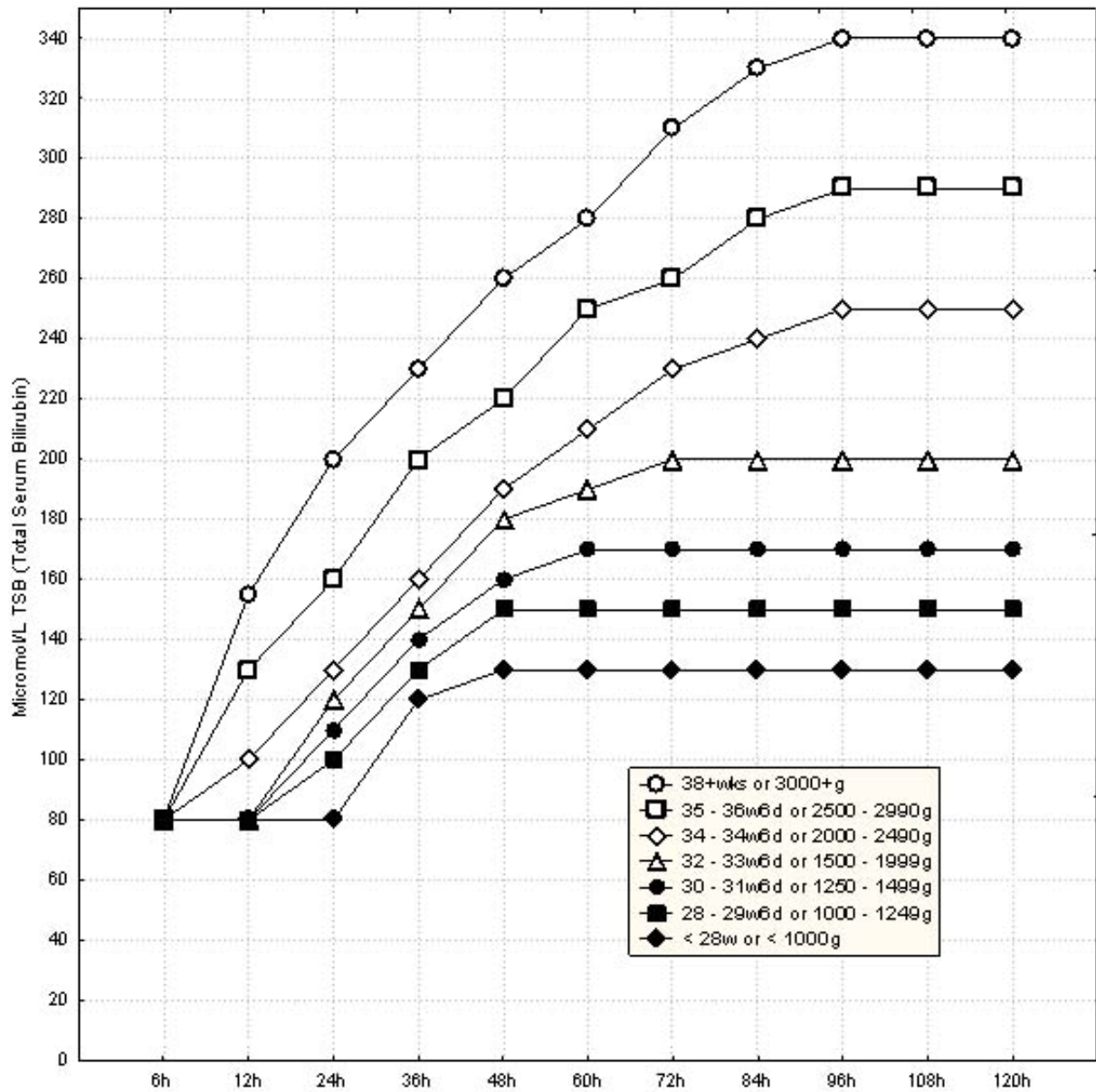
##### 3. What precautions should be taken if a sample of capillary blood is collected for a PCV?

The heel must be warm and should not be squeezed. Otherwise the PCV result will be falsely high.

##### 4. How should this infant be managed?

As the infant appears well there is no special treatment needed. However the infant should be observed for jaundiced.

Figure 24-2: Phototherapy chart for infants in different birth weight and gestational age categories (e.g. 34 to 34 weeks and 6 days or 34 to less than 35 weeks).



(AR Horn: Neonatal Medicine, UCT).