

THAMES VALLEY & WESSEX NEONATAL OPERATIONAL DELIVERY NETWORK

Nursing Guideline for Treating Neonatal Jaundice with Phototherapy, Including Guidance on Exchange Transfusion.

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Implications of race, equality & other diversity duties for this document	This guideline must be implemented fairly and without prejudice whether on the grounds of race, gender, sexual orientation or religion.

1.0 Aim of Guideline Framework

This guideline has been produced to direct staff in their care of neonates receiving phototherapy to treat jaundice. They are based on research findings and/or currently accepted best practice. For accessibility, the guidelines have been collated under distinct subheadings; however, the reader is advised to read the guidelines in full and to seek the advice and support of more senior or experienced colleagues, in the practice setting.

2.0 Scope of Guideline Framework

The guideline applies to all neonatal units and maternity units covered by South Central Neonatal Networks. This includes the following hospitals:

Thames Valley		
TRUST	Hospital	Designation
Oxford University Hospitals NHS Foundation Trust	- John Radcliffe Hospital, Oxford	NICU
Buckinghamshire Healthcare NHS Trust	- Stoke Mandeville Hospital, Aylesbury	LNU
Frimley Health NHS Foundation Trust	- Wexham Park Hospital, Slough	LNU
Milton Keynes University Hospital NHS Foundation Trust	- Milton Keynes General Hospital	LNU
Royal Berkshire NHS Foundation Trust	- Reading	LNU

Wessex		
TRUST	Hospital	Designation
University Hospital Southampton NHS Foundation Trust	- Princess Anne Hospital	NICU
Portsmouth Hospitals NHS Trust	- Queen Alexandra Hospital	NICU
Dorset County Hospital NHS Foundation Trust	- Dorchester	SCU
Hampshire Hospitals Foundation Trust	- Basingstoke	LNU
Hampshire Hospitals Foundation Trust	- Winchester	LNU
Isle of Wight NHS Trust	- St Mary's Hospital	LNU
Poole Hospital NHS Foundation Trust	- Poole	LNU
Salisbury NHS Foundation Trust	- Salisbury	LNU
Western Sussex Hospitals NHS Foundation Trust	- St Richard's Hospital, Chichester	LNU

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3.0 Guideline Summary

Monitoring jaundice.

- Parents, carers and healthcare professionals should all be encouraged to look for jaundice, by visual inspection of the baby
- If jaundice is suspected after 24 hours of age, the jaundice level must be formally checked within 6 hours.
- If jaundice is suspected in the first 24 hours of life, the jaundice level must be formally checked within 2 hours.
- Transcutaneous monitoring can be performed using a transcutaneous bilirubin meter, if a baby is 35 weeks gestation or greater. In addition they must be older than 24 hours and not received any phototherapy.
- The interval between tests will be based on; the clinical condition of the baby, its gestation and the previous trend in rise or fall of the sbr.

Prior to Commencing phototherapy.

- Any obvious cream or oil residue visible on the baby's skin should be gently wiped off.
- Check the baby's temperature before commencing phototherapy.
- Babies receiving overhead phototherapy should have as much skin as possible exposed to the light, so hats and bed covering should be removed.
- Eye protection goggles designed for the purpose should be used for all babies receiving overhead phototherapy.
- See grid on p 9 for guidance in commencing the three different types of phototherapy commonly available.

Ongoing phototherapy.

- Recheck the baby's temperature within 1 hour of commencing phototherapy.
- Monitor and record the baby's temperature at least every 3 hours- more frequently if required.
- The baby's fluid balance must be monitored and any changes or concerns reported to the medical team.
- Babies should be monitored for indicators of dehydration
 - Urine volume, frequency and urine analysis (bilirubin may be present)
 - Stool volume, frequency and consistency.
 - Daily weighing of baby
- Clean skin only with water
- An incubator cover or cot canopy should be used to protect babies from the phototherapy lights, who are neighbouring phototherapy but not receiving it themselves.

- For guidance on the safe use of individual types of phototherapy refer to manufacturers guidelines for use.
- Document any changes in phototherapy treatment, for example use of additional phototherapy or current plan for time baby allowed out from phototherapy-if at all.
- Keep parents informed about their baby's progress
- Encourage and support parents to interact with and care for their baby whilst receiving phototherapy.
- Staff should remember that as a baby's sbr falls parents should be able to have longer and more frequent opportunities for cuddles and kangaroo care, -dependant on the baby's condition.
- Remember that babies receiving phototherapy commonly pass very loose and watery stools so are likely to need their nappies changing more often.

Ceasing phototherapy.

- It is common practice to stop phototherapy treatment when a baby's sbr level has fallen below the treatment level for their age and gestation. These treatment levels are dictated by national NICE neonatal jaundice guidelines.
- Measure and record the baby's temperature prior to ceasing phototherapy.
- Recheck the baby's temperature within 1 hour of ceasing phototherapy.
- Recheck the sbr level within 12 hours or as clinically indicated, in case of rebound.
- Be aware that an sbr level can rise days after phototherapy has been discontinued

Exchange Transfusion (ET).

- Handover any other patients to colleagues, as the procedure is likely to take 2-3 hours and at least one nurse and doctor will need to be allocated solely to performing this task.
- Ensure resuscitation equipment and medications are easily accessible.
- Attempt to make the baby settled and comfortable, with nesting, swaddling, use of a pacifier- as the procedure is not painful, but will run more smoothly if the baby is settled.
- It is usual for the baby to be nil by mouth during the procedure- and for 4 hours after wards, due to the risk of NEC.
- Phototherapy should continue during the procedure.
- Place the baby on full cardio-respiratory monitoring.
- Blood must be prescribed and checked in the usual way before administration.
- Medical team will check a blood gas and other tests at the beginning of the procedure and regularly throughout the procedure using the waste blood, just removed from the baby
- Record vital signs every 15mins. Ensure aseptic process is maintained throughout the procedure.
- Each aliquot of blood will be removed and replaced over an agreed time span- ie 5 minutes. Team members will take care to ensure this process is not sped up.
- Regularly check the 3 way taps settings of the ET set, to ensure the blood is flowing in the correct direction- to prevent accidental loss or infusion of blood.
- If it is necessary to pause for any reason during the procedure, ensure the venous catheter is full of new blood, which is anti-coagulated, or heparinised saline, and the arterial line is flushed to remove blood. As leaving the baby's own blood in either of the lines will cause it to clot and block the line.
- After the ET is complete, continue monitoring vital signs every 30 mins for the next 4 hours.
- Run fluids through the venous and/ or arterial lines sited for the ET to maintain their patency, until it is confirmed that the sbr has stabilised, and these lines can be removed.
- Document procedure in the nursing record.

4.0 Guideline Framework

This guideline has been reviewed and updated to comply with and take into account the NICE Clinical Guideline 98.1 -Neonatal Jaundice published May 2016.

Guideline Treating Neonatal Jaundice with Phototherapy Guideline - V4 - March '18. TV & W Governance group ratified: 4.12.2019

Neonatal Generic email: england.tv-w-neonatalnetwork@nhs.net

Neonatal Website: <https://southodns.nhs.uk/our-networks/neonatal>

4.1 Background information.

Neonatal Hyperbilirubinaemia (jaundice) is very common and affects approximately 50% of full term infants and 80% of preterm infants in the first three days of life (NetsVictoria, 2007 and Trueman, 2006). It accounts for up to 75% of all hospital readmissions in the first week after birth (Melton, 1999).

There are two different types of jaundice- 'Pathological' and 'Physiological'. Pathological jaundice is that which is considered to be outside of the normal process such as that which arises within 24 hours after birth or after 14 days of age. It is as a result of factors which interfere with the usual processes involved in bilirubin metabolism such as in the case of blood incompatibilities or metabolic disorders (Wentworth, 2005).

The most common type of jaundice affecting neonates is physiological. This is as a result of increased haemolysis (breakdown) of foetal haemoglobin (red blood cells). Bilirubin is a byproduct of this process. In utero the foetus will excrete bilirubin via the maternal blood and hepatic systems. After birth the baby's own liver takes over the process transporting the unconjugated (fat soluble) bilirubin, bound to albumin in the bloodstream, converting it to conjugated (water soluble) bilirubin by a complex process of enzyme activity. It is then excreted via the biliary system into the intestines as a waste product. Unconjugated bilirubin is the fat soluble version which has not passed through the excretion process and it can become toxic to the body if it remains at high levels. Due to the immaturity of the neonatal liver and the sluggish intestinal transit the bilirubin breakdown process may be slow and unable to keep up with the rate of production.

Factors predisposing to Physiological Jaundice:

- Shortened lifespan of red blood cells
- Polycythaemia from placental transfusion (delayed cord clamping)
- Bruising from traumatic delivery
- Dehydration
- Delayed intestinal transit time
- Sepsis (may interfere with normal liver processes and increase haemolysis)

Jaundice is often recognised by the yellow discolouration of the baby's skin but it can be difficult to recognise in those of different ethnic backgrounds such as African and Asian. The most common and accurate method of diagnosing hyperbilirubinaemia is by blood sampling to check serum bilirubin (SBR) levels either in the lab or on the unit bilirubinometer. Different plotting charts are used to plot the serum bilirubin levels-often related to gestational age for safe serum levels.

When the SBR is above the recommended treatment level the baby will be commenced on phototherapy treatment. The amount of phototherapy lights used will be dependent on the individual sbr level. Phototherapy is the use of visible light for the treatment of neonatal hyperbilirubinaemia (Stokowski, 2006). It acts by lowering the serum bilirubin level by converting bilirubin into water-soluble isomers that can be eliminated without conjugation in the liver. The dose of phototherapy determines how quickly it works and the dose is determined by the wavelength of the light, the intensity (irradiance), the distance between the light and the neonate and the baby surface area exposure.

Suggestions in the literature advise that bilirubin breakdown is most sensitive to blue and blue-green colour regions of the visible spectrum (Wentworth, 2005). Fibre optic phototherapy has also been suggested as greatly increasing effectiveness when combined with other phototherapy units in reducing jaundice levels.

Where SBR levels are close to or above exchange levels, on the treatment charts, more intensive treatment may be recommended by the medical staff. (for example no time out from phototherapy or careful fluid balance monitoring. Blood may need to be ordered in preparation for an exchange transfusion. Further investigations will need to be performed to ensure that there is not an underlying pathological cause for the hyperbilirubinaemia.

It is vital that neonates are treated for hyperbilirubinaemia as soon as it is recognised/diagnosed to prevent further complications. The greatest concern is for the baby to develop 'kernicterus' (bilirubin encephalopathy). This is a condition triggered by high levels of unconjugated bilirubin crossing the blood-brain barrier entering the basal ganglia and cerebellum and disrupting cellular metabolism and reducing protein synthesis in the mitochondria. The baby will become lethargic, hypertonic, irritable and may develop seizures and respiratory disorders as a result of the kernicterus. This emphasizes the importance of early treatment and recognition of jaundice to prevent it reaching this dangerous level.

More recently there has been concern expressed about the association between neonatal phototherapy and infantile cancer. Whilst authors conclude that phototherapy slightly increases the risk of cancer in infancy (Wickremasinghe et al 2016) they summarise, that as with most other treatments (having both benefits and potential risks) phototherapy's use should be limited to infants for whom the benefit/ risk balance is most likely to be favourable.

4.2 Practice Guidelines

4.2.1 Prior to Commencing phototherapy

- Thermoregulation is an important consideration when commencing phototherapy, as the baby's clothing is likely to be removed, their environment altered either by removing blankets and sheets or placing the baby into an incubator. In addition, a heat source will be added in the form of phototherapy equipment. This all means that staff will need to be aware of the various changes being made in quick succession to the baby. By monitoring their temperature carefully, care can be individualised to ensure thermoregulation is unaffected.
- Measure and record the baby's temperature before commencing phototherapy.
- Any obvious cream or oil residue visible on the baby's skin should be gently wiped off using cotton wool and water. This is because there is a risk that the cream or oil may exacerbate the effect of heat from the phototherapy and or the light wavelengths emitted and cause the baby's skin to be burnt.
- Staff should make themselves aware of their unit's policy for fluid management when a baby is commenced on phototherapy, in case changes are required.
- See grid below for guidance in commencing the three different types of phototherapy commonly available;

Guidelines on commencing bili-bed phototherapy.
Gather a clean bili-bed and a clean bili-combi-baby suit
Attach suit to bed base using velcro fastenings
Dress baby into suit- ensure the front fastenings are closed
The baby should be nursed only in a nappy within the suit
The use of eye shields is recommended for babies on a bili-bed, by the manufacturers of the bed.
The bili-bed should be sited securely in a cot with deep enough sides to prevent any risk of the bili-bed moving. This usually requires the mattress to be removed from the cot.
The baby should be monitored on an apnoea monitor, of the type that adheres to the abdomen. If none of this type are available then pulse-oximetry monitoring will be required.
Guidelines for commencing bili-blanket phototherapy.
Place a clean disposable cover on the bili-blanket
The bili-blanket can be used either in a cot or an incubator.
Ensure the light pad is positioned so that the correct surface is positioned facing towards the baby's skin.
The generator box which powers the bili-blanket must not be placed on top of the incubator if a baby is nursed in an incubator, due to the high levels of noise and vibration that it emits.
The cooling fan vent of the generator box must not be obstructed.
Take care when positioning the baby onto the light pad, as it has a firm surface and the baby is at risk of pressure sores on its bony surfaces, such as elbows, knees, head and pelvis.

The baby should be monitored using an apnoea monitor if not already having pulse-oximetry monitoring. However the firm surface of the light pad may reduce the effectiveness of the 'mattress style' apnoea monitor. If this occurs pulse-oximetry monitoring must be used instead.
Position the baby on the light pad to give maximum exposure to and contact with the pad.
Consider using eye protecting pads for the baby. If the baby is small enough that their face or eyes will be near the light pad then eye pads will be needed.
Guidelines for commencing overhead phototherapy.
The overhead light should be positioned as close as possible to the baby without causing risk of burning or overheating. For appropriate distances (usually between 10-50cm) see manufacturer's guidelines for different types of overhead phototherapy unit.
All babies will require eye protection pads (the baby's eyes should be closed before these are put on the baby.)
Remove all of the baby's clothing except for the nappy before commencing phototherapy.
The baby should wear the smallest appropriate nappy to maximise skin exposure. If the jaundice level is very high then the baby may be nursed on a flattened open nappy or absorbent pad. There is no risk to the gonads of chromatic radiance damage if there is a layer of perspex between the phototherapy bulb and the baby. Perspex is fitted on all commonly used overhead units.
Ensure the baby is positioned under the central focus of the phototherapy light.
Where more than one overhead phototherapy light unit is being used together the lights should be positioned around the baby to provide an even distribution of irradiance on the exposed surfaces of the baby. Seek advice from more experienced colleagues if uncertain about correct positioning.

- The NICE guidelines (2010) accept that multiple phototherapy will be required in certain clinical circumstances. These are when the baby's sbr is rising rapidly (8.5mcmmol/l/hr), the sbr is with 50mcmmol/L of exchange transfusion level- after 72hrs of age, and/or the sbr has failed to respond to single phototherapy. If multiple phototherapy treatment is commenced and the sbr subsequently falls to a level of 50mcmmol/L below the threshold for exchange transfusion, then a 'step down' can be made to single phototherapy.
- Multiple phototherapy is defined by NICE (2010) as phototherapy that is given using more than one light source simultaneously; for example two or more conventional units, or a combination of conventional unit and fibre optic units.

4.22 Temperature regulation.

- Measure and record the baby's temperature prior to commencing phototherapy.
- Recheck the baby's temperature within 1 hour of commencing phototherapy.
- Monitor and record the baby's temperature at least every 3 hours- more frequently if required.
- Aim to keep the baby's temperature between 36.6 and 37.2 C
- There is a high possibility that the baby's incubator will become warmer with the use of phototherapy and that the incubator temperature will need to be reduced to ensure the baby does not overheat.
- There is a high possibility that babies nursed exposed in open cots will lose heat and may require the room temperature to be increased to ensure the baby's temperature does not drop.
- The likely changes in the baby's temperature are effected by the number of phototherapy units in use and also the particular model. For example LED type overhead phototherapy produces almost no heat.

4.23 Eye care.

- There is no current evidence to show that light exposure in neonates damages the eyes or contributes to the development of retinopathy of prematurity (ROP.) However it is clear that exposure to bright lights is unpleasant and uncomfortable for all humans and disturbs sleep patterns and reduces the ability to sleep at all. In addition physiology of the preterm infant means that their eyelids are very thin and allow light through, they are unable to effectively contract their pupils and will often sleep with their eyes partly open. For all these reasons it is

very important to effectively protect the eyes of baby's on phototherapy from excessive light exposure.

- For babies 37 weeks gestation and upwards, a tinted facial shield may be used to protect the eyes of babies. But only under conventional blue light therapy.
- Eye protection pads are the preferred option for protecting a baby's eyes from the phototherapy. This is because they;
 - stay in place despite movement by the baby
 - allow exposure of the maximum amount of skin
 - are more effective than eye shields at blocking light from the eyes.
- Eye protection pads carry risks of complications for the baby so must be used with care. Complication noted include;
 - apnoea due to pads slipping and obstructing the nostrils
 - eye irritation
 - corneal abrasion
 - blocked tear ducts
 - conjunctivitis
- Good practice when using eye protection pads includes;
 - Using pads designed for the purpose
 - Not altering the pads in any way
 - Choosing the correct size pads for the baby
 - Not securing the pads too tightly (to avoid damage and discomfort)
 - Never securing the pads to the face with tape to stop them moving
 - Replacing the pads over the baby's eyes as soon as noted to be dislodged
 - Checking the internal aspect of the pads for signs of eye discharge or other contaminants and changing pads if contamination noted
 - Removing the pads with cares to check the baby's eyes for evidence of swelling, redness, oedema, abrasion or infection.
 - Giving the baby opportunity with cares (even if only briefly) to open their eyes and look around.
- Good practice for babies neighbouring phototherapy but not receiving it themselves includes;
 - Ensuring the incubator cover (for babies nursed in incubators) is positioned so that it blocks the phototherapy from shining into the incubator. It must also be large enough that it is still being effective at blocking other light sources from the room.
 - A dark cover can be hung from the actual overhead phototherapy unit, to prevent it spreading light into the room, however care must be taken that the air vents are not blocked by the cover.
 - Babies in cots should have a cot canopy to protect them from stray phototherapy light.
- Staff with specific medical problems that may make them sensitive to the phototherapy lights should be referred to occupational health for advice and information.
- There should be acknowledgement and provision made for staff or visitors who may (rarely) be adversely affected by the phototherapy lights. Consider contacting ophthalmology or occupational health for advice.
- Consider using the white light bulb as well as the blue phototherapy light to reduce the glare for staff and visitors and other babies. This option is only available when using certain models of overhead phototherapy unit, which have this facility.

4.24 Fluid balance

- The choices available for feeding any baby receiving phototherapy are affected by the level of a baby's serum bilirubin (sbr) level and the current trend of the sbr which could be up, down or static and changing rapidly or steadily. Examples of common practice are tabulated below.
- Some studies have found babies receiving phototherapy have side effects of increased fluid loss from evaporation and loose stools due to increased bowel transit time. Therefore, babies receiving phototherapy should have their fluid balance monitored and any changes or concerns reported to the medical team.
Aspects to monitor and record include;
 - Urine volume, frequency and urine analysis (bilirubin may be present)

- Stool volume, frequency and consistency.
- Daily weighing of baby

Baby has a very high sbr for their age and gestation and/or their sbr is rising very rapidly
-baby must stay under phototherapy at all times, including during medical procedures or nappy changes
-feeds must either be by tube, or bottle with the baby being bottle fed in the cot or incubator
-the baby may not come out for cuddles
-the use of iv fluids is likely, to help 'dilute' the sbr and perhaps to speed up the hydration of a dehydrated baby

Baby has a high sbr for their age and gestation but the level is being well controlled
-feed times out from under the phototherapy are time limited, ie 30 mins
-whilst breast or bottle feeding the baby is kept on the bili blanket which comes out of the bed with them
-no cuddle times except for during feeds, although if the baby is not being fed then a short cuddle is acceptable
-all basic medical procedures and nappy changes to occur under the lights

Baby has a moderate or low sbr, which is well controlled and the level is falling
-staff can be more flexible with the time a baby is allowed out for feeds, but parents should be encouraged to put the baby back under the phototherapy when the feed is complete
-babies may have time out of the phototherapy for cuddles, but this should not be for prolonged periods
-if possible the baby coming out of bed for a feed should still be nursed on the bili blanket.

- Babies who require phototherapy should be monitored for indicators of dehydration, which include;
 - Weight loss
 - Poor urine output, or urine with a high specific gravity
 - Wrinkled skin with poor skin turgor
 - Sunken eyes
 - Sunken fontanelle
 - Dry mucosa

4.25 Skin care

- Rashes and spots can develop or become more prominent, usually only temporarily. But if the phototherapy lights are too hot or too close to the baby there is a risk of overheating the skin.
- Avoid the use of skin creams or oils on skin exposed to the phototherapy light
- Clean skin only with water
- Be vigilant about skin preparation products that may get left on the skin, ie chlorhexidine or betadine. These should be removed fully after use.
- Be aware of pressure area for all babies nursed on a bili blanket or bili bed. Particularly premature infants who have very little subcutaneous fat to protect them from the firm surfaces
- Babies receiving overhead phototherapy should have as much skin as possible exposed to the light, so hats and bed covering should not be used. Babies receiving only bili bed or bili blanket phototherapy can have bed covers and hats.

4.26 Checking the sbr level

- Parents, carers and healthcare professionals should all be encouraged to look for jaundice, by visual inspection of the baby.
- If jaundice is suspected in the first 24 hours of life, the jaundice level must be formally checked within 2 hours.
- If jaundice is suspected after 24 hours of age, the jaundice level must be formally checked within 6 hours.

See the NICE guidelines on Neonatal Jaundice- for explicit instructions.

- The frequency of sbr level checking for each baby felt to be jaundiced or receiving phototherapy will vary between every hour and every 24 hours. The interval between tests will be based on; the clinical condition of the baby, its gestation and the previous trend in rise or fall of the sbr
- There are three different methods to assess the jaundice level of a baby
 - **Blood tests are the method of choice as they are the most reliable**
 - Transcutaneous monitoring can be performed using a transcutaneous bilirubin meter, if a baby is 35 weeks gestation or greater. In addition they must be older than 24 hours and not received any phototherapy. Studies have shown that the results are not as reliable as from a blood test, however, this method is helpful as a simple and pain free way of assessing the approximate sbr level of a baby who appears jaundiced. If the transcutaneous sbr level is found to be elevated then this can be used as an indicator to check sbr using a blood test
 - Visual examination of the baby's skin and eye colour (the whites can turn yellow) is very frequently used as the first indicator that a baby may be jaundiced and can direct a nurse or doctor to check the baby's sbr formally using a blood test. The baby should be naked for examination and if possible- in bright natural light. Visual appearance of jaundice must never be used as the sole guide for commencing phototherapy.
- Any staff member performing sbr checking must have been trained and assessed as competent to
 - Take blood specimen
 - Spin sample in the centrifuge
 - Read the sbr result
 - Accurately document the result according to local practice
 - Pass the result on to the medical team
- Babies requiring blood tests to check sbr should receive non-nutritive sucking and oral sucrose as pain management during and after the procedure. If possible, try to group blood tests that the baby requires so that they are disturbed less and experience less discomfort. Grouping blood tests will require staff to negotiate with their colleagues.

4.27 Equipment.

- For guidance on the safe use of individual types of phototherapy refer to manufacturers guidelines for use.
- Equipment used for monitoring jaundice and administering phototherapy, should be regularly serviced and well maintained.
- There is no difference in the effectiveness of conventional blue light and LED phototherapy. However, most users find the LED phototherapy easier to use. In addition, babies have less need for additional fluids, because there is no heat output from the LED phototherapy.

4.28 Cessation of phototherapy

- It is common practice to stop phototherapy treatment when a baby's sbr level has fallen below the treatment level for their age and gestation. These treatment levels are dictated by national NICE neonatal jaundice guidelines. However it is not uncommon for the baby's sbr level to 'rebound', or rise back above the treatment level when phototherapy is discontinued. In order to take account of this it is accepted practice to;
 - Ensure sbr is on a downward trend before stopping phototherapy
 - Recheck the sbr level within 12 hours or as clinically indicated, in case of rebound.
 - Be aware that an sbr level can rise days after phototherapy has been discontinued

- As when commencing phototherapy, temperature instability is common when phototherapy is ceased due to the removal of an additional heat source it is most likely that a baby will get cold. With awareness of this it is important to;
 - Measure and record the baby's temperature prior to ceasing phototherapy.
 - Recheck the baby's temperature within 1 hour of ceasing phototherapy.
 - Aim to keep the baby's temperature between 36.6 and 37.2 C
- There is a high possibility that the baby's incubator will become cooler with the ceasing of phototherapy and that the incubator temperature will need to be increased to ensure the baby does not get cold.
- There is a high possibility that babies nursed on a bili-blanket will lose heat and require more bedding, clothing or their incubator temperature increasing.

4.29 Documentation

- Use local phototherapy care plan if available
- Record sbr results as soon as available, using the NICE threshold guideline charts. Additional sites for documentation are likely to include; in the current page of the medical notes and on the general blood results grid.
- Document all observations as per the guideline (temperature, fluid balance, changes in baby's condition)
- Document any changes in phototherapy treatment, for example use of additional phototherapy or current plan for time baby allowed out from phototherapy-if at all.

4.30 Parents

- Keep parents informed about their baby's progress
- Encourage and support parents to interact with and care for their baby whilst receiving phototherapy.
- Explain jaundice, the care involved with phototherapy and the plan of treatment for their baby
- Provide parents with written information / electronic information to back up verbal information and for parents to take away.
- Explain the ways in which parents can still be involved in their baby's care.
- Wherever there are options that the parents can choose from discuss them with parents and allow them to control these choices. For example whether their breast feeding baby who cannot come out from the phototherapy can be bottle fed or if they would prefer that the baby to be tube fed.
- Support mothers to express breast milk if they are not able to breastfeed their babies during phototherapy.
- Explain to the parents why it is important that their baby stays under the phototherapy for the majority of the time.

4.31 General Care

- Nesting and comfort measures are very important for babies exposed for phototherapy as the babies feel very vulnerable without clothes, bedding and the usual contact with parents or carers.
- Nesting may encircle the baby but must not be positioned so it obstructs the light. Commercially available nests are often very deep and may not be suitable for use with phototherapy however effective nests can be made using rolled up blankets or towels.
- Remember that babies receiving phototherapy commonly pass very loose and watery stools so are likely to need their nappies changing more often. They also have an elevated risk of getting peri-anal excoriation. (See the Thames Valley and Wessex Neonatal Network Guideline for Skin Integrity)
- Making up a baby's bed using white sheets will increase the overall amount of phototherapy that a baby receives (irradiance) as the light bounces off the white sheets, when compared to coloured bedding.
- A study has shown that white curtains draped around the cot or incubator in which phototherapy is being given, will increase the irradiance received by the baby. However it is

not recommended that this technique be used due to a lack of equipment designed specifically for this purpose. The phototherapy cooler fan may become obstructed and there must be concern about the enclosed environment meaning babies are at risk of re-breathing their own expired air.

- Staff should remember that as a baby's sbr falls parents should be able to have longer and more frequent opportunities for cuddles and kangaroo care, -dependant on the baby's condition.

5.0 Neonatal Exchange Transfusion.

5.1 Back ground information.

In simple terms an exchange transfusion (ET), is the process by which aliquots (small portions) of the baby's blood are removed and replaced concurrently with donor blood. Enabling abnormal blood components or toxins to be removed, whilst maintaining adequate circulating blood volume.

The aim of an ET for the severely jaundice baby is to lower serum bilirubin level and reduce the risk of brain damage (kernicterus.) An ET is only used when other methods of treatment have been ineffective.

Simultaneous exchange is the preferred method for ET and ideally requires an arterial and a venous line. An aliquot of blood (usually 5-20mls depending on the bay's size) is removed slowly from the arterial line, whilst simultaneously an aliquot of blood is pushed in via the venous line. The blood may also be administered using a infusion pump, as a rate equal to that of the aliquots being withdrawn.

If venous access to the baby is limited, it is possible to perform an ET using just one line using a push pull method. This occurs when an aliquot of blood is removed and then an aliquot of blood is immediately administered down the same line. A special 'four way tap' exists which is designed for the purpose (see Fig 1). However this 'push and pull' technique has many disadvantages, including; a lengthier procedure, more risk of procedure error and an increased chance of derranged blood values.

5.2 Preparing for exchange transfusion.

Medical responsibilities.

- The final decision to perform an ET will be made by the consultant on call, based on
 - SBR levels and response to treatment
 - Clinical presentation of the baby (signs of bilirubin encephalopathy)
- Before commencing the procedure informed consent should be gained from the baby's parent/ guardian, after both the benefits and risks have been fully explained.
- To decide how much blood to remove and replace, a formula is used, which relates to the baby's circulating blood volume. (Term infants 80ml/kg or preterm infants 100ml/kg.) For hyperbilirubinaemia it is usual to perform a 'double exchange transfusion'. This will mean that;
 - 2 x the baby's circulating blood volume will be exchanged.
 - 85% of circulating blood volume would be replaced.
 - The sbr level would usually be reduced by 50%.
- Blood will be ordered especially for the procedure that is suitable. This will usually be;
 - Cross matched again infant and maternal blood group and antibodies.
 - Leukocyte depleted
 - Irradiated and used within 24hrs of irradiation.
 - CMV negative
 - As fresh as possible- with a maximum 5 days old.
- Venous and Arterial access will be required before the procedure can go ahead, parents should have been informed of this during the consent process
- These lines will need to be sited before the procedure can commence.
- An arterial line will be used to withdraw blood from the baby, and a venous line for administering blood. This can be achieved in 3 ways;

- Umbilical venous catheter and Umbilical arterial catheter
- Umbilical venous catheter and Peripheral arterial catheter
- Peripheral venous cannula and Peripheral arterial catheter.

Nursing responsibilities.

- Handover any other patients to colleagues, as the procedure is likely to take 2-3 hours and at least one nurse and doctor will need to be allocated solely to performing this task.
- Ensure resuscitation equipment and medications are easily accessible.
- Gather a trolley or similar to provide additional working surface.
- Bring a clock/ timer to the baby's bedside, for easy and unified timing of the procedure.
- Where possible, nurse a baby 34 weeks or older under a radiant warmer on servo mode, or similar, for easy access. Babies less than 34 weeks should remain within their incubator for the ET.
- Attempt to make the baby settled and comfortable, with nesting, swaddling, use of a pacifier- as the procedure is not painful, but will run more smoothly if the baby is settled.
- Place the baby on full cardio-respiratory monitoring.
- Document a full set of base line observations.
- The baby will usually be NBM during the procedure, so if not already in place, site an ngt/ ogt and aspirate stomach contents.
- Ensure the baby continues to receive their maintenance fluids/ TPN infusion, unimpeded by the occurrence of the ET process.
- Phototherapy should continue during the procedure.
- Gather all necessary equipment;
 - Plastic aprons/ gloves and protective eye wear
 - Sterile gloves/ drapes
 - Exchange transfusion set and recording sheet (where not available these will need to be created using available equipment.)
 - Blood warmer- if used locally
 - Sterile drape
 - Equipment for blood gases and blood tests.
- Blood must be prescribed and checked in the usual way before administration.

5.3 Commencing the procedure.

Nursing responsibilities.

- Check the baby's identification before the ET begins.
- Phototherapy will continue whilst the ET is performed.
- Record vital signs every 15mins including
 - Heart rate and rhythm.
 - Oxygen saturation.
 - Temperature both surface and central.
 - Respiratory rate and effort.
 - NBP/ Invasive blood pressure.
 - Colour, tone and behaviour.(turn off phototherapy to do this)
 - Checking limb perfusion and colour if arterial line in situ.

Medical responsibilities.

- Medical team will check a blood gas and other tests at the beginning of the procedure and regularly throughout the procedure using the waste blood, just removed from the baby. This usually includes;
 - Full blood count
 - Blood gas
 - U&Es- particularly checking (Na, Kcl, Ca, Mg, Creatinine)
 - Sbr level
 - Blood sugar

- If any blood result is derranged, it will be necessary to cease the ET and treat the imbalance, before continuing with the ET.
- The commonest complications to be observing for are;
 - Hypo/ Hyperglaycaemia
 - Hypo/ Hyperkalaemia
 - Hypocalcaemia
 - Metabolic acidosis
 - Thrombocytopaenia
 - Air embolus
 - Anaemia
 - Necrotising Enterocolitis (NEC)

5.4 Exchange Transfusion Process.

- It is usual for the doctor to lead the ET and be the sterile person withdrawing aliquots of blood from the baby. Usually the nurse, will record the blood volume out and blood volume in on the exchange transfusion record sheet after every aliquot of blood is exchanged. They will also perform the multiple observations and record these.
- If a third member of staff is available then they can be sterile and take control of the blood being administered, helping to reduce the risk of confusion or errors.
- Ensure aseptic process is maintained throughout the procedure.
- Each aliquot of blood will be removed and replaced over an agreed time span- ie 5 minutes. Team members will take care to ensure this process is not sped up.
- Whenever an aliquot of blood is removed or administered, this will be verbally announced by the person who has done this (ie "Five mls out") - to help ensure accurate recording of the ET process.
- Running totals of blood in and blood out should be recorded at least every 100mls, to minimize the risk of errors or imbalances.
- Regularly check the 3 way taps settings of the ET set, to ensure the blood is flowing in the correct direction- to prevent accidental loss or infusion of blood.
- It is usual to retain all blood that has been removed from the baby until the end of the procedure- often syringes are lined up in order on a trolley surface. In case of any doubt about blood given or removed- these syringes can be referred to, giving reassurance that the process is occurring correctly.
- If the infant's condition suddenly deteriorates, and the ET needs to be ceased, ensure that their blood volume has been left in balance.
- If it is necessary to pause for any reason during the procedure, leave the venous catheter full of new blood, which is anti-coagulated, or heparinised saline, and flush the arterial line to remove blood. As leaving the baby's own blood in either of the lines will cause it to clot and block the line.
- Continue process until pre-calculated exchange volume is reached.
- The last withdrawal of blood should be saved for post exchange blood tests.

5.5 After the Exchange Transfusion.

- Ensure the baby is clean and dry and comfortable.
- Continue high intensity phototherapy.
- Run fluids through the venous and/ or arterial lines sited for the ET to maintain their patency, until it is confirmed that the sbr has stabilised, and these lines can be removed.
- Ensure parents have been informed the procedure is completed, and the outcome of the procedure.
- Document procedure in the nursing record.
- Continue monitoring vital signs every 30 mins for the next 4 hours.
- Check blood sugar every hour until stabilised.
- Check serum bilirubin level one hour after ET, and then according to jaundice protocol. Note-It is expected that sbr level will rebound to approximately two thirds of pre-exchange level.

- It would be usual for the baby to remain NBM for at least 4 hours after the procedure due to risk of NEC
- Observe for signs of infection, feed intolerance or other abdominal symptoms of NEC.

5.6 Paperwork.

- See appendix Fig 2 for an example of documentation used during the exchange transfusion process.

6.0 Appendix.

Fig 1. Description of method and image showing '4-Way' tap used for the 'push/ pull' method. Oxford (2016)



Step 1

Arm of '4-way' tap directed to venous catheter

Withdraw aliquot of blood from the baby into the syringe

Turn stopcock through 90° clockwise

Step 2

Arm of '4-way' tap is now directed to 'removed blood' container.

Expel removed blood

Turn stopcock through 90° clockwise

Step 3

Arm of '4-way' tap is now directed to new blood bag

Draw aliquot of new blood into syringe

Turn stopcock through 180° back to its original position

Step 4

Arm of '4-way' tap is now directed to the venous catheter again

Inject new blood into baby

Return to step 1

Fig 2. Sample of Form used to record exchange transfusion process. See next page.

EXCHANGE TRANSFUSION RECORD

File in babies notes when completed

Baby label

1. Calculate volume of exchange, volume and number of aliquots

• 180 mls / kg =

• Number of aliquots

Volume of each aliquot

2. Initial investigations

• Baby's blood group

Direct anti-globulin test

• Mother's blood group

3. Preparing baby in anticipation of need for exchange transfusion

- Site umbilical venous catheter (or peripheral arterial line) for exchange procedure (check position of UVC on X-ray)
- Site second peripheral cannula
- Two members of staff available through out procedure (may last 2-3 hours)
- Ensure resuscitation equipment is to hand
- Continuous ECG monitoring
- Continue phototherapy during exchange

4. Take pre-exchange bloods from baby

Na

K

Ca

glucose

Hb

plats

bilirubin

Blood gas

PCV

Baby label

5. Commence exchange transfusion

- Record each aliquot removed and replaced on exchange log

- Pulse rate, temperature recorded every 5 minutes, blood sugar every 30 minutes
- Agitate the donor pack at intervals to prevent settling
- Electrolytes, ionised calcium, glucose, Hb, PCV and pH plus bilirubin should be measured at midway and end of exchange (gas machine values acceptable)
- Check FBC and platelets at end of exchange

If baby develops a bradycardia, goes pale or appears on pain – STOP exchange

6. Take bloods from baby midway through exchange

Na K Ca glucose

bilirubin Blood gas

PCV

7. Take bloods from baby at end of exchange

Na K Ca glucose

Hb plats bilirubin Blood

gas PCV

8. Inform parents that procedure has been completed

- Catheters should be left in place until no further exchanges are required

9. Consider plan for ongoing phototherapy and timing of measurement of next bilirubin level.

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