Birmingham Heartlands Hospital
Good Hope Hospital

NEONATAL UNIT GUIDELINES

Summer 2010:

DISCLAIMER:
These guidelines are valid only within Birmingham Heartlands Hospital until September 2012

See also separate files with appendices on occasional procedures and drug guideline file

Please do not deface or change these guidelines

Do not add to them

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Introduction

- These guidelines are intended for the use of medical and nursing staff on the Maternity Units and NNU for the care of new born babies at Birmingham Heartlands and Good Hope Hospitals.
- Their use should bring a uniformity of approach to clinical problems, and should help resolve any clinical disagreements over the care and management of clinical problems in babies.
- **However, these guidelines are not dogmatic and not all have a proven scientific basis. The clinician may therefore use alternative approaches, provided that the reasons for those approaches are clearly documented in the notes.**
- The guidelines in this version (Summer 2010) will be considered out of date as of September 2012.
- We hope there are no mistakes, but if there are, please let a consultant know. At present Dr Singh edits them. **Always follow the formulary in case of any differences in drug dosage.**
- The guidelines are incomplete, if there are particular topics you would like to see included soon, please let him know
- The guidelines have been written and regularly updated since 1987.
- The main authors are shown by initials at the end of each section:

CB Carol Barley
ABR Alison Bedford Russell
JF Jackie Fisher
VF Vikki Fradd
SH Scott Hackett
TK Tina Kipioti
SL Sheena Lewis
JM Jeff Martin
TM Tauseef Mehrali
RHM Richard Mupanemunda
SP Simon Parke
CR Carol Rasburn
SJR Steve Rose
AnS Anju Singh
AS Angela Sly
IT Irina Tiron
MW Mike Watkinson
JS Jaideep Singh
AG Anjum Gandhi
JMe Joanne Meran

Please refer also to the appendices in a separate folder on occasional procedures.

Comments to: Dr Singh

SOME HEALTH ISSUES FOR DOCTORS AND NURSES on NEONATAL UNITS.

1. **You must be Hepatitis B immune. If you are not sure please go to Occupational Health.**

2. **You must be familiar with the basic guidelines over HIV and practise them.**

3. **Some babies will be excreting CMV. If you are pregnant, consider this issue carefully.**

4. **If you have concerns over health issues relating to your work then:**

   a) Contact Occupational Health

   b) 'Contact' is a (free) support and stress counselling service for doctors in training is on 0121 558 0278 with an answering machine out of hours.

   c) The consultants and the senior nurse/unit manager are there to offer confidential help - and have often done so in the past. If you are having difficulties, talk to them before things get too bad.

   d) There is an experienced psychologist who works with us and has helped team members in the past.

BOOKS ON THE NEONATAL UNIT

It is sad to report that, over the years, many hundreds of pounds of textbooks have been taken from the unit and not returned.

This benefits neither the babies nor the staff and we have therefore had to lock up the books in the secretaries' office. Please borrow these as often as you wish. However, if you borrow a book from there and do not return it, you will be asked to pay the cost of replacement.

Some larger core textbooks are left out on the unit as 'benchbooks' to help with immediate clinical problems in the more complicated and sick babies. Sadly, even some of these books have been taken…….

Handwashing

- Babies, especially preterm babies, are susceptible to infection and care must be taken to prevent cross infection. Handwashing is the single most important procedure.

- **Full cooperation with the infection control team is expected.**

- We do occasionally have babies with MRSA colonisation. **Gloves and aprons must be worn** when handling these babies.

- Please read the article from the BMJ below..

On arrival on the NNU:

- Watches, and, if possible, rings must be taken off
- Roll up your sleeves (MRSA will survive in fabrics).
- Wash your hands thoroughly with the appropriate medicated soap), taking care to wash up to the elbows, between fingers, and at the thumb and finger tips.

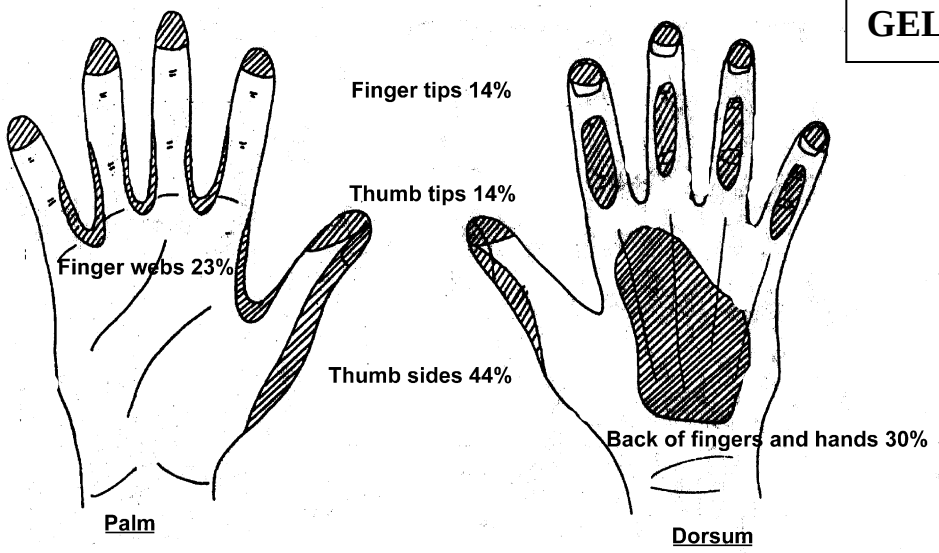
Between Babies:

- Wash hands BEFORE and AFTER handling a baby using an alcohol based hand rub, using approximately 3 ml of the rub.

- Allow your hands to dry between babies.

The figure below, (after Gloag and Wright 1985) shows the parts of the hands that we most often miss unless taking particular care in handwashing The percentages show the proportion of people failing to wash a given area.

GEL – BABY - GEL



MW revised April 2005 & May 2010

Hand Hygiene

EXTRACTS FROM BMJ
EDITORIAL AUGUST 2001

Use alcohol hand rubs between patients: they reduce the transmission of infection

"In recognition of the fact that washing with soap and water is not the only (or even the most effective) way of reducing the transmission of organisms, the hand hygiene liaison group has some practical recommendations on easy ways of improving hygiene.

Hospital acquired infections in the United Kingdom cost around £1bn a year and affect nearly 10% of patients, causing over 5000 deaths a year (more than deaths on the road) and taking up thousands of bed days. MRSA, a surrogate marker for hospital acquired infection, is now responsible for 47% and 68%, respectively, of all cases of *S aureus* bacteraemia and surgical wound infection. The National Audit Office report suggested that hand hygiene recommendations should be implemented as part of the NHS's national plan.

Systematic review evidence identified several well designed studies showing that patient contact resulted in contamination of health care workers' hands by pathogens. For example, staff dressing wounds with MRSA have an 80% chance of carrying the organism on their hands for up to three hours. Another study showed that 40% of all patient-nurse interactions on an intensive care unit resulted in transmission of *Klebsiella* to the nurses' hands, even after minimal contact such as touching a patients shoulder. Organisms remained on hands for up to 150 minutes. Similar data are available for Clostridium difficile. Hand washing removed the organisms.

Formal hand washing with soap and water is required when there is soiling. When there is none the hand hygiene liaison group now advocates that staff should use an alcohol-glycerol hand rub between patients. Alcohol hand rubs are quick to use (10-20 instead of 90-120 seconds) and can be used while walking and talking. Thus they overcome objections to hand washing, including lack of time, lack of sinks, and skin damage. Indeed, a recent study has shown that such hand rubs cause less irritation than soaps. The Epic systematic review would appear to support this strategy because it shows that though liquid soap and water decontaminate hands, 70% alcohol or an alcohol based antiseptic rub decontaminates hands more effectively for a wide variety of organisms, including *S aureus, Pseudomonas eruginosa, Klebsiella* spp, and rotavirus.

We found 9 studies (3 RCTs, five controlled trials, and one multiple crossover trial) showing major reductions in infection related outcomes across a wide range of clinical settings. The effect is so great (commonly reported odds ratios and relative risks of 0.4) that if "hand hygiene" were a new drug it would be accepted without question.

Mathematical modelling suggests that even small increments in hand hygiene may be highly effective in controlling, for example, endemic MRSA. The risk of transfer on carers' hands is proportional to the power of the number of times a patient is touched.

The issue is no longer whether hand hygiene is effective, but how to produce a sustained improvement in health workers' compliance.

Where do we go from here? Firstly, all healthcare workers need to be aware of the current evidence underpinned by the new national guidelines and our own review. The need to integrate effective hand hygiene into clinical governance in association with risk management has been highlighted recently. Every trust should have as a standard that alcohol handrub is available at every bedside, and hospital acquired infection should be one of the key performance indicators because it is an important marker of the quality of patient care. Long term change in behaviour requires that all staff, especially senior staff, take responsibility for ensuring that hand hygiene becomes an every day part of clinical culture."

Consent

The Heartlands NNU guide for consent in neonatal medicine is based upon the BAPM guidelines. After discussions between consultants and junior NNU staff at Heartlands, some amendments were made. The introduction and tables below **are** the BAPM guidelines except where "(BAPM)" is shown. That indicates the BAPM advisory position, the tick in the box adjacent to this indicates the Heartlands NNU approach. BAPM also published a staff leaflet, and **extracts** of that are immediately below.

Consent in neonatal clinical care

Good practice framework

It is a legal and ethical requirement to gain valid consent before examining and initiating any investigation and treatment for any patient. Failure to seek consent is not an option. In neonatal practice there are occasions when no-one available to provide valid consent and the clinician has to initiate treatment in its absence. It should always be possible later to justify the action to the parents, and to reassure them that it was in the best interests of the baby.

This leaflet aims to provide guidance to those working with newborn babies clarifying when, from whom and how consent should be gained in different circumstances. It is hoped that this will provide a standard for the gaining of consent. The term 'explicit consent' is used to describe the situation when the purpose and risks of an intervention are formally explained and consent, either verbal or written, is obtained and recorded prior to the intervention. Implicit consent is used to describe situations where it is judged that the nature and risk of a procedure is such that a less formal, and often retrospective transfer of information about the intervention is considered sufficient. Implicit consent as defined here, is by its very nature dependent upon the building up of rapport and trust between clinicians and parents.

Principles

1. Consent is obtained from someone with parental responsibilities; this will usually be the parents
2. The basis of valid informed consent is the establishment of clear two-way communication and is an on-going process. Consistent communication will increase the parents' trust and confidence in the medical and nursing team and decrease the likelihood of problems.
3. Consent is valid only when the information provided has been understood by the parents and explains why the intervention is recommended, its risks and the implications and options should consent be withheld.
4. It will not usually be necessary to document consent to routine and low risk procedures
5. In emergency, if consent cannot be obtained (e.g. nobody with parental responsibility is available or the parents are too distressed to give valid informed consent), treatment may lawfully be started if clinicians believe it to be in the child's best interests
6. Consent may be written, verbal or implied. Documentation indicating the information given to parents and their apparent understanding and agreement to proceed is the most important validation of consent. A signature does not of itself confirm informed consent.
7. The gaining of explicit consent, whether with or without a signature, should be witnessed and the name of the witness recorded.
8. Parents should understand that they can withdraw consent for investigations and treatments not yet completed. If the clinical team believe that this is counter to the interests of the baby they should discuss this with the parents and may need to take advice which in the first instance should be from the hospital's senior management team and/or Social Services.

Good practice

1. Whenever possible communication with the parents should begin antenatally both through meetings with neonatal staff and using written material.
2. Written material should be available for the parents of all babies admitted to the neonatal unit, describing the nature of low risk procedures such as venesection, for which explicit consent would not normally be sought.
3. The availability of written material and the perception of a procedure as low risk does not obviate the need for the clinician to explain its purpose and if appropriate to explain any risk and the implications of withholding that procedure.
4. Counsellors and advocates should be available to support parents.
5. The assumption that implied consent has been gained must be made with caution in neonatal practice; whenever possible all procedures should be explained to the parents.
6. If you have any reason to believe that consent might be disputed later it should be documented in the notes even for a low risk procedure, in this situation it is particularly important that the presence of a witness is recorded.
7. If treatment is complex, or involves significant risks or side effects explicit consent must be gained and it is good practice for this to be signed. All NNUs should have leaflets describing common surgical procedures, including a summary of risks and options, that can be used as a basis for discussions between paediatricians and parents prior to transfer to the surgical centre and should the surgeon have to gain consent over the telephone. In this situation the witnessing of consent is important and consideration should be given to using a conference call or faxing a witnessed signed form. Contemporaneous notes of all such conversations are essential.
11. Consent for post-mortem examination should be taken by a member of the consultant staff unless there is a junior doctor trained to use the consent form and who was particularly involved with the family. In many instances pathologists are happy to talk to parents themselves and this should be encouraged.
12. In order to minimise distress in circumstances where difficulty around gaining consent is predictable because of cultural and religious factors, e.g. a Jehovah's witness family, discussion about options should, if possible, begin early before an emergency arises.
13. A list of available information leaflets, training in communication and the local policy for gaining of consent for examination and treatment should form part of the induction training of all clinical staff.
14. Junior doctors and nurses should, with the parents' agreement, attend discussions between senior staff and parents for training purposes.
15. Staff might find it helpful to consider how they would themselves respond in the parents' place and what explanations and reassurances would make it easier for them to understand why an intervention is recommended.

"These lists (on the following pages) have been agreed by a working group convened by BAPM, with representation from the Neonatal Nurses Association, ANNPs and from BLISS and in consultation with the BAPM membership. The objective has been to include all procedures that might be performed on neonatal units. The lists have been produced in conjunction with a leaflet summarising the principles of gaining valid consent and good practice in neonatal care. It must be emphasised that the gaining of consent is not an option and all procedures should be explained to parents whether or not the working group recommends that explicit consent is obtained. These lists do not include items that the group regards as part of normal care including issues around the choice of breast and formula milk, the use of the latter while awaiting colostrum or aspects of care such as bathing and the use of dummies. This is not because these are considered any less important but rather in the trust that these are routinely discussed with parents and supported by written information.

In April 2005 the Chief Executive of the NHS sent out a DOH circular letter:

European Court of Human Rights Ruling – Consent to Treatment

I ….. bring to your attention the judgment in a case of the European Court of Human Rights where doctors treated a child contrary to his mother's wishes, without a court order (*Glass v United Kingdom*) and to remind you of the importance of having a system in place to handle issues of parental objection.
I would be grateful if you would …. remind members of staff who are involved in the treatment and care of children … of their legal responsibilities when there is conflict between parents and doctors and the child is not competent to provide consent.

The treating staff of the child in the case (David Glass) thought that he was in the process of dying. They wanted to give him morphine to alleviate his suffering, but his mother did not, believing it would compromise his chances of recovery. However, the treating staff went ahead and administered diamorphine to the child. The mother took the case to the European Court of Human Rights and argued that as it was clear that there was dispute over the treatment to be given to David, the hospital should have involved the courts to clarify whether, despite his mother's objections, the treatment was in David's best interests. The Court of Human Rights found that the NHS Trust's failure to bring the dispute before a court was a breach of the child's right to private and family life protected under Article 8. The Court said that there had been indications that there was a dispute over treatment, some time before crisis point was reached, and the UK High Court could have been used to settle the dispute, before an emergency situation arose. The guidance from the Department of Health (*Seeking consent: working with children, 2001*) is that in the event of a continued disagreement between parents and doctors, parental refusal can only be overridden in an emergency, and if there is a dispute in other situations, the court should be involved. The *Glass* judgment made clear that the failure to refer such cases to the court is not only a breach of professional guidance but also potentially a breach of the Human Rights Act.

Procedure	Explicit consent not USUALLY required	Explicit consent recommended
	These procedures should be described in written information available to parents at admission, this can be expanded by clinical staff as the opportunities arise. It should not USUALLY be necessary to record consent in the notes.	When explicit consent is obtained, whether verbal or signed, this should be recorded in the notes. For those procedures marked with an asterisk it is recommended that explicit consent is supported by a signature (written consent).
Examination and Investigations		
Examining & assessing the patient	√	
Clinical photographs and video-recordings		√*
Routine blood sampling	√	
Septic screens	√	
Diagnostic LP to investigate possible infectious or metabolic illness	√	
SPA	√	
Screening of babies and/or their mothers in high risk situations with no prior knowledge of maternal status eg. suspected HIV or substance abuse		√
Screening for infection in response to positive results of maternal screening eg. Known maternal HIV or substance abuse	√	
CMV, toxoplasma, rubella and herpes screening	√	
Genetic testing (incl karyotype)		√
Portable X-rays and ultrasounds	√	
Gasrointestinal imaging involving contrast	√	(BAPM)
Procedures involving the baby leaving the unit		
X-rays	√	
Ultrasound	√	
Videoflouroscopy	√	
MRI / CT with or without contrast	√	
EEG / CFAM	√	
EEG with video recording		√
ECG	√	
ROP screening	√	

Procedure	Explicit consent not USUALLY required	Explicit consent recommended
Practical Procedures		
All surgical procedures	□	√*
UAC / UVC	√	
Percutaneous arterial lines	Radial, ulnar or pedal	Brachial or femoral
Percutaneous long lines (incl. use of contrast medium to visualise tip)	√	
Peripheral venous lines	√	
Naso-gastric and naso-jejunal tubes	√	
Tracheal intubation	√	
Ventilation / CPAP	√	
Chest drain insertion and replacement	These procedures usually need to be done as an emergency. However, they carry risk and parents need to be fully informed about them and the likelihood of repeat procedure at the first suitable opportunity. √	(BAPM)
Abdominal drainage for perforation or ascites		√
Irrigation following extravasation injury	√	(BAPM)
Urethral catheterisation	√	
Therapeutic lumbar or ventricular tap in the absence of a reservoir (to relieve raised intracranial pressure, deliver IT antibiotics etc)		√
Peritoneal dialysis		√*
Bone marrow aspiration		√*
Any biopsy		√*
Blood transfusion	√	
Use of pooled blood products	√	
Exchange transfusion	√	
Partial exchange transfusion	√	
Antibiotics	√	
Vitamins / minerals	√	
IV fluids	√	
TPN	√	
Surfactant	√	

Procedure **Explicit consent not USUALLY required** **Explicit consent recommended**

Anti-convulsants	√	
Sedation for intubation & ventilation	√	
Inotropes	√	
Indomethacin or ibuprofen for PDA	√	
Prophylactic indomethacin	√	
Parenteral and oral vitamin K for babies admitted to the NNU	√	
Vitamin K for normal term babies		√
Nitric Oxide	√	(BAPM)
Postnatal dexamethasone for BPD		√
Postnatal dexamethasone for laryngeal oedema	√	
Immunisation		√*
Treatment for ROP		√*
Nutrition		
Breast milk fortification	√	
Use of donor breast milk		√

Revised May 2010 MW

References

Gloag A, Wright E. P aeruginosa in a NNU. Midwives Chronicle & Nursing Notes 1985;January:7-9
Taylor LJ. Nursing Times 1978: January 12th and 19th;pp 54-5 and 108-10
Teare L, Gookson B, Stone S, Hand hygiene**.** BMJ, 2001; **323**: 411 - 412.
http://www.bapm.org/documents/publications/consent_procedures_20041200.pdf accessed 22/4/2005
http://www.bapm.org/documents/publications/consent_leaflet_20041200.pdf accessed 22/4/2005
The Children Act 1989 and Adoption and Children Act 2002: Those with parental responsibility include: parents if married, mother but not father if not married unless he has acquired parental responsibility via a court order or parental responsibility agreement, an individual caring for the child such as a childminder if authorised by the parent, a legally appointed guardian, a Local Authority designated in a care order or holding an emergency protection order.
In 2003 in England, Wales and Northern Ireland but not Scotland, an amendment to the 1989 Children Act gave parental rights to unmarried fathers named on the birth certificate.
DoH 2001. Good practice in consent implementation guide: page12, paragraph 5
BMA Books 2000. Consent, Rights and Choices in Healthcare for Children and young People: Ch11, Summary of Good Practice, Page 231
Department of Health 2001. Seeking consent: Working with children: page 17
Department of Health 2001. Good practice in consent implementation guide: page 20, paragraph 1.
Department of Health 2001. Seeking consent: Working with children: page 16

ADMISSIONS

EARLY CARE ON NNU

Criteria for NNU and Transitional care admissions

Heartlands and Good Hope Neonatal Unit:

1)* All infants under 1800 g birth weight, and consider those under 2200 g

2)* All infants under 35 weeks gestation **must be admitted. At Good Hope those below 32 weeks should be transferred out to a level 2 or level 3 unit.**

3) All infants with severe birth asphyxia

4) Severe (life threatening) congenital abnormalities, unless plan is to remain with parents

5) Infants with proven or suspected severe haemolytic disease

6) Infants who have had convulsions

7) Infants with cyanotic or apnoeic attacks

8) Some infants of drug addicted mothers (discuss)

9) Infants with signs of RDS

10) Pyrexial infants

* Some of these babies may go to transitional care if all else is well

IF IN DOUBT: ASK FOR SENIOR ADVICE.

Admissions to BHH Transitional Care

1) Infants of insulin treated diabetic mothers

2) Well, small babies who need glucose monitoring (Medisense) for the first 48 hours.

3) Hypothermic babies (e.g. those born before arrival)

4) Babies with feeding difficulties (e.g. babies with cleft lips/palates)

5) Babies with low Apgar scores who then appear well after resuscitation but merit additional supervision for the first 24 hours

6)All jaundiced babies needing phototherapy, including those readmitted from home (with their mothers).

In general, babies should not be admitted to transitional care if it is obvious that they will not be ready to go home with their mother.

MW/SJR Revised May 2010 MW

Neonatal alert form

A reduced version of the neonatal alert form is shown below. It is usually printed on white paper with a purple edging. The 'Suggested Actions' box is to be filled in by the 3rd on consultant for the week, and then the form is photocopied before being put in the mother's notes. A copy of the form is also kept in a file on NNU. Please follow the guidance offered on the form whenever possible.

NEONATAL ALERT FORM

Name: LABEL Date of Birth: Hospital Number:	Name of obstetrician Name of midwife: EDD:

Dear Dr. Fradd/Mupanemunda/Rose/Watkinson,

This lady is booked for delivery at Birmingham Heartlands Hospital. Antenatal history suggests that there may be a problem requiring neonatal intervention after delivery.

PROBLEM: *(Please provide details, examples overleaf)*

Person completing form to write 'See Neonatal Alert Form' on pregnancy health record

……..

……..

Signed: ……. Obstetrician/GP/Midwife (*circle as appropriate)*

Name: …….. Date: …….
(please print)

SUGGESTED ACTION – to be completed by the paediatricians

……

……

and
Registrar/Consultant to discuss with mother before delivery
SHO to attend delivery
Registrar to attend delivery
SHO to review baby within 24 hours of delivery
Registrar to review within 24 hours of delivery

Signed: ……. Paediatrician: ……

Name: …….. Date: …….
(please print)

If not filed, original to be returned to Pat Bagshawe, Maternity Reception for filing in mother's notes
Photocopy to be put in Neonatal Alert File kept on NICU
Photocopy to Neonatal Alert File on Labour Ward
Photocopy to Julie Tindale for MIS alert

Original form by Dr K I Blake & Dr A Morgan, Walsgrave Hospital. November 1998.

Admitting when unit is 'full'

It is hard to give universal rules, but these guidelines may help.
Always discuss the bed state with the nurse in charge.

	ITU full *TELL BHH and GH* *LABOUR WARD STAFF*	*ITU has empty cots*
In Utero Transfers IN	**No transfers in,** unless a returning BHH baby who is **not** for ITU	Accept babies < 32 weeks in utero. Decline older babies, but offer to collect post-natal if ventilation needed. Accept post-natal transfers for ITU
IN UTERO OUT FROM BHH & GOOD HOPE	Transfer out in-utero all babies < 30 wks (< 32 weeks at GH) if delivery likely within 24-48 hours	If only one space consider in-utero transfer out of twins < 32 if delivery likely within 24-48 hours

,After each morning round, the consultant and nurse in charge will agree on the number of 'open' intensive care, high dependency and special care cots up to a maximum capacity of 36 total at BHH and 16 at GH.

When the IC cots are full, follow the chart above. The main points are:

- the obstetricians must be informed and be asked to transfer out all women about to deliver babies at < 30 weeks gestation (< 32 weeks at GH).
- Babies above this threshold must be born here and assessed. Occasional post-natal transfers may be needed as a result of this.
- If the obstetricians feel that a woman < 30 to 32 weeks pregnant is too ill to transfer, again the baby **must** be born here and assessed - even if NNU is full.
- Refuse all requests to transfer babies in until an IC cot is available

MW, SL, JF, AS 1999, revised MW May 2010

Admitting under different consultants

Heartlands:

The NNU has a 'First-on' consultant for a week at a time from 0900 Friday to 0900 the following Friday. During that week, all babies will be admitted under that consultant.

GHH :

Admission of babies from the community immediately after birth

Community midwives are asked to bring the following babies to the NNU directly from home for admission, observation and any necessary treatment:

1. Babies with 5 minute Apgar score <5
2. Babies who needed bag and mask resuscitation
3. Any baby about whom a midwife is concerned.

MW
Revised March 2003 & May 2010

Admitting very preterm babies – the first 24 hours

1) TEMPERATURE CONTOL

- Place infant in a humidified incubator
- If a bag or a Transwarmer mattress have been used, only remove them when temperature is normal and alternative thermal care is ready
- Cover with bubble sheeting
- The temperature may have to be set > 37^{o}C to maintain the baby's temperature..

2) AIRWAY CONTROL

Assess need for intubation - generally all $\leq$ 27 wks need intubation or CPAP

A) Initial Ventilator Settings

- Assist Control mode
- Inspiratory time (Ti) 0.3 sec, Expiratory time (Te) 0.7 sec
- Therefore, rate 60 bpm (back up rate), **reducing to 35 bpm** when stable
- Peak pressure 16, PEEP 3
- $F_1 0_2$ 0.4
- Flow rate 8 1/min

B) Surfactant

- on labour ward if intubated for resuscitation at < 30 weeks
- as soon as possible on NNU if ventilated.
- Do not wait for x-ray.

C) Arterial gas 1 hour after initial settings and review settings.

3) MONITORING

- Temperature
- Pulse oximetry
- ECG if skin mature (use pulse oximeter heart rate at 24-25 weeks)
- Blood pressure monitoring should be invasive if possible.

4) MAINTAIN BLOOD PRESSURE

a) If low BP - check trace is not damped

b) **<u>If</u>** low BP confirmed:

- No evidence of hypoxia
  Initially 10 ml/kg N Saline or FFP if clotting deranged

- In hypoxic infant
  Initially Dopamine 10 ug/kg/min

- Consider hydrocortisone

5) FLUIDS

- Cover with bubble sheeting to create a humid, draft-free microenvironment

- 10% Dextrose - as a **minimum** 60 mls/kg . Fluid regimen to alter depending on electrolytes, osmolality and weight changes. Please refer to fluid and electrolyte guidelines
- Twice daily E & U although this may not be necessary for all
- Fluids to increase if Na concentration or osmolality raised.

6) VASCULAR ACCESS

- Umbilical arterial line if: intubated or F_i0_2 >0.4
- Double lumen UVC
- Peripheral (avoid potential long line sites)
- Peripheral long line if no UVC

7) ANTIBIOTICS

- Penicillin + gentamicin.

8) VITAMINS

- Vitamin K 0.5 mg IM
- Vitamin E 25 mg/kg/dose - daily for 3 days

9) INITIAL INVESTIGATIONS

- FBC
- INR/PTTK (A clotting screen and glucose/Medisense can be done through the UAC immediately after insertion if the catheter is primed with non-heparinised saline)
- Blood culture
- Group and save (and ensure 10ml clotted maternal blood sent to lab)
- E & U, creatinine, Ca (Glucose if Medisense low)

10) JAUNDICE

- Phototherapy should be considered individually -
- but initially commence phototherapy at SBR > 85 - 100 micromol/l.
- Consider 'prophylactic' phototherapy if severe bruising in very preterm baby

11) PARENTS

- Allow to see/handle as early as possible, preferably before stabilisation
- Photograph, before intubation if practicable
- Go and see mother if she is ill on Labour Ward
- Encourage breast feeding/expression of milk

12) FEEDING

- Information about end - diastolic flow
- Slow introduction of breast milk
- Intravenous nutrition

13) SKIN

- Minimal use of sticky tapes on skin
- 50/50 mix white soft paraffin/liquid paraffin to skin
- No H bridges for UAC.
- Elastoplast across catheter, stitch Elastoplast to umbilical stump/skin.
- If sticky tape is used, allow to fall off if possible: no peeling
- Humidify closed incubators
- Ensure turning to prevent pressure sores
- Ask nurses to monitor sites where cannulas and short 'long lines' end

NON ITU PROTOCOL

- Transfer to incubator

- Monitors: ECG, Pulse oximetry

- Fluids: a) 10% Dextrose, 60 mls/kg/day

- Review for need to do FBC/U and E . Discuss with senior.
- Vascular access: a) Peripheral iv line
- Umbilical arterial if $Fi0_2$ >0.4

- Feeding: a) Information about end-diastolic flow
- Slow introduction of breast milk

SJR/MW reviewed May 2005 & May 2010

Golden hour

The next four pages are copies of the sheets on display in the Intensive Care room. They attempt to summarise a combined nursing and medical approach to very preterm babies of <26 weeks gestation. They also set a reasonable time schedule for the care plans to be achieved. If you are falling behind, please call for extra help.

TIME	NURSES	DOCTORS and ANNPs
Before birth	• Prepare transport incubator • <u>On NNU prepare</u>: • incubator with high temp (>37^{o}C) and humidity • ventilator & monitors • 10% dextrose infusion • 0.45% saline + heparin • Trolley with UVC/UAC pack ready • Scales • Umbilical packs	• See the parents: discuss birth plan • <u>Ensure</u> • registrar or a consultant can attend • resuscitaire and small ETTs ready • polythene bag ready • Transwarmer Mattress activated *just before* birth and wrapped in towel • Surfactant ready on labour ward (don't open yet) • ? suitable for any trials/studies • Discuss with the consultant
At birth	• Assist with resuscitation • Keep the baby warm • Vitamin K – withhold and give IV on NNU • Set up transport incubator	• Resuscitate • **Intubate** • **Give surfactant on Labour Ward (120mg vial of Curosurf)** • **Keep baby warm, use bag and Transwarmer mattress** • Show parents briefly (10 – 20 secs) if possible
Arrival in NNU	• Keep in plastic bag and towel • Weigh in bag and towel, take towel off, place baby in bag in incubator, weigh towel • Place under large bubble wrap under radiant heater • Establish on ventilator • **Set up temperature & oximeter monitors only** • (ECG only if SaO_2 pickup is poor) • Tell doctor you are ready for UVC/UAC insertion (see before birth above)	• Allow time to set up temp/SaO_2 monitors • Split tasks between doctors: • <u>Doctor A</u>: • Check/adjust ventilator settings • Prepare surfactant if not given at birth • Prescribe drugs and initial fluids • <u>Doctor B</u>: • Write forms • Label bottles & send off specimens (as below) • **DO NOT INSERT PERIPHERAL DRIPS AT THIS POINT.**
5 to 30 minutes after arrival	• Keep in plastic bag • Ensure IV and IA solutions ready • Assist with/insert cannulas/UAC • Start infusions through lines after catheter insertion (before Xray) • Vitamin K 0.5mg IV neat • Monitor temperature/SaO2 • Medisense recording with first blood sample	• Surfactant if not given at birth • Access cord through a small hole in the plastic bag • Insert UVC primed with **N saline,** • Take bloods: FBC, Group, Clotting screen, Culture, E+U, Ca, Medisense and Glucose. Start glucose infusion via UVC. Do not add IV sodium at this stage. • **Insert UAC:** **- if not in within 15 minutes, call next senior doctor** • Take bloods for gases.
30 to 60 minutes	• Establish BP monitoring • Review drug & fluid prescriptions - ? appropriate ? complete ? clear • Set up diamorphine infusion • Keep baby in plastic bag under bubble wrapping	• Review gases, make necessary changes to ventilation. • If gases poor - ? DOPE = Displaced tube, **O**bstructed, **P**neumothorax, **E**quipment problems. • Correct any hypoglycaemia • Treat hypotension if present (mean BP < gestation) • Give initial antibiotic doses • Order CXR & AXR for ETT/catheter positions - don't wait 4 hrs. • See parents & allow them to see baby • Insert peripheral arterial/IV lines if UAC/UVC failed

REGISTRAR PROCEDURES AT 23 TO 26 WEEKS

The golden hour is up!

EVERYBODY: EYES ON! HANDS OFF!

Once the baby is 'set up', don't fiddle, don't touch

60 to 120 minutes	• Check monitoring complete • Check ETT/drips/monitor leads **secure** • Report abnormal readings to doctor • Remind doctors of 'overlooked' drugs or procedures! • Photograph for parents • Information booklet and data collection information sheet for parents	• Repeat gases if first abnormal or if on HFO • Check fluids OK for gestation/radiant heat etc • Start phototherapy if bruised ++ • Review mother's antenatal notes and take history from parents for further risk factors in history. Note cord pH. • Plan timing of further gases, bloods, CXRs. • Discuss with consultant if still problems
Later	• Transfer to closed humidified incubator • Admit onto computer system • Only remove plastic bag when temperature is normal and stable	• Consider long line if no UVC and delayed enteral feeding • Head scan

INTENSIVE CARE OF THE BABY OF 23 - 28 WEEKS: **NOTES FOR DOCTORS AND NURSES:**

SKIN CARE

- As little tape as possible, while still being safe to secure cannulas
- No tape for venepuncture sites: use cotton wool and press!
- Minimal 'transpore' to be applied to skin
- Use 'Hyperfix' wherever possible
- If very immature skin, no ECGs, just BP trace & oximetry
- **Do not pull off sticky tapes**: carefully cut drips/chest drains free and allow tape or Opsite etc to peel off over days
- UAC must be stitched to umbilicus, not stuck with 'bridge' to abdominal skin
- Use 50% white/50% liquid paraffin sparingly to raw areas of skin or to whole body if very immature
- No heel pricks while UAC in situ

INITIAL VENTILATOR SETTINGS

- Peak pressure 16 – 18 mbar
- PEEP 3 – 4 mbar
- Rate 60 bpm
- Ti 0.3 secs
- SIPPV / SIMV
- Airway temperature not less than 37^{o}C

- Don't forget CPAP as an option!

MICRO-ENVIRONMENT: a localised area of stable high temperature and high humidity for the baby

- **Do not disturb the micro-environment unless absolutely necessary!**

- Create a 'micro-environment' ASAP:
- Only remove plastic bag when temperature is normal and stable
- place whole baby under a large bubble wrap
- reduce draughts – sides up and close doors and windows
- Do not cover with woollen blankets if under a radiant heater
- Transfer to a well humidified closed incubator capable of temperatures up to 38.5^{o}C when the baby is stable &procedures complete.
- Maintain micro-environment within incubator
- Phototherapy can be given through bubble wrap

FLUID MANAGEMENT

- All babies will need at least 30ml/kg/day extra under a radiant heater
- In babies with very immature skin, trans-epidermal water loss (TEWL) is high and increases with skin damage
- A 500-600g 23 to24 week baby under radiant heaters & phototherapy may need as much as 150ml/kg/day on Day 1
- If fluid intake is high, use 5% dextrose to reduce hyperglycaemia
- Check E+U at least twice daily initially and weigh once or twice daily if possible

Gestation (weeks)	Birthweight (kg)	Starting volume (ml/kg/24hr) under a radiant heater	Starting volume (ml/kg/24hr) in an incubator
< 27	< 1.0	120 – 150	90
27 – 30	1.0 – 1.5	90	60

This table has been modified from a more detailed one in Roberton: Textbook of Neonatology, 3rd edition, page 1019.
That table presumes 50% humidity.

Under a radiant heater, relative humidity will be < 15%. In a well humidified closed incubator it may be > 90%. Adjust fluids accordingly.

Survival by gestation for normally formed babies admitted to Heartlands NNU 2009

Weeks of gestation	< 25 weeks	25 -26	27-28
Survival at BHH 2009	50%	60%	95%

Fluid and electrolyte management in premature infants

Premature infants need careful fluid and electrolyte management especially in the first week of life. It is important to remember that fluid and nutritional requirements will differ between sick infants and there is no such thing as a 'one size fits all' approach. In particular, very preterm infants, those with significant lung disease or renal impairment, and infants who have received an asphyxial insult often require more individualised regimens.

This guideline describes the broad approach currently recommended and has been developed from consensus opinion and review of the literature. **Remember this is a guide only, if you are unsure what to prescribe then discuss with a senior colleague.**

SUMMARY

- Most babies can be started on 60ml/kg/day. Use 10 % dextrose as the initial fluid.
- Use the birth weight to calculate intakes. Use this till weight has increased above birth weight. After that, use the most recent weight unless there is inappropriate weight gain (fluid/ oedema).
- **Fluid intake,** most can be increased to 90 and then 120ml/kg/day and finally 150 mls/kg/day on days 2, 3 and 4 of life respectively.
- Decrease fluid loss from the skin by using humidity within the incubator for infants < 29 weeks gestation.
- Check plasma glucose after fluids established (and at least daily for first 4-5 days unless well and stable on enteral feeds).
- Check electrolytes [Na]&[K] at 12-24 hours of age. Most infants will need daily electrolytes for the first few days of life. Some infants will benefit from more frequent measurements.

- Indications for TPN which should be started on next working day include:

  o preterm <30weeks **and** <1000g;

  o more mature babies who are not likely to achieve full enteral feeds in the first 5-7 days e.g. severe IUGR and abnormal Doppler studies, hydrops etc.
  o babies with GI problems e.g. NEC
  See separate parenteral nutrition guidelines.

1. **Fluid.** Water comprises up to 90% of the weight of preterm babies, and water provided as dextrose is an essential component of fluid regimens. A small decrease in ECF fluid volume (diuresis) takes place in all babies over the first 2-3 days. Check the blood glucose using the Medisense analyser after an i.v. infusion has been running for 2-3 hours. All infants need daily blood glucose for the next 5-7 days but very preterm infants and other at risk babies need much more regular glucose monitoring. Hyperglycaemia is common. If glucose >10mmol/L consider insulin infusion.

2. **Sodium.** Sodium management is closely linked with water administration. Immature tubular function in preterm infants impairs both their ability to excrete and retain sodium. Avoid extra sodium wherever possible until weight loss/diuresis has been achieved.
After the first week, infants <28-30 weeks need approximately 5mmol/kg/day of sodium. More mature infants may only need 3mmol/kg/day.

3. **Calories and protein.** Preterm babies need at least 40-50kcal/kg/day to satisfy basal metabolic requirements but they need at least 100-120kcal/kg/day to grow (very preterm infants may need 120-150kcal/kg/day). Preterm infants need at least 3- 4 g/kg/day protein.

4. **Increasing total fluids**. Fluid regimes require individualisation. Babies can generally be increased to 90 ml/kg on day 2 and 120ml/kg on day 3 and 150 mls/kg on day 4. Fluid requirements need to be considered individually taking into account the urine output, weight and electrolyte results. These infants thus need at least 24 hourly and sometimes 12 hourly fluid balances. Some babies on intra-venous fluids may need more than 150 ml/kg/day depending on blood results. Discuss with senior colleagues. Enterally fed babies can have their feeds gradually built up to 180 - 200 mls/kg/d.

Special Circumstances

1. Phototherapy – additional 30ml/kg/day of fluid.
2. Post GI surgery – replacement of NG losses/stoma losses with normal saline in addition to requirements.
3. HIE – restrict fluids to 40ml/kg/day initially and manage fluids depending on renal output see Cooling guidelines.
4. NEC/suspected NEC – not for enteral feeds, will need central line and IV fluids, ideally TPN.

Bibliography

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Parentral Nutrition

Neonatal Parenteral Nutrition

Aims

- To provide the nutritional requirements for optimal growth and development of the infant while full enteral feeds are being established

Background

Many low birth weight babies are unable to receive their full enteral requirement in the first week of postnatal life and unless they are provided with appropriate amounts of carbohydrate, fat and protein a negative nitrogen balance and catabolism will occur.
This early deficit may be of significance regarding future growth, resistance to infection and neuro-developmental outcome.
There is a paucity of randomised control trials comparing parenteral nutrition (PN) to other forms of nutrition in matched populations and few studies showing that PN decreases either morbidity or mortality. It is now unlikely that these studies will be performed as PN is widely used in the neonatal population and withholding its use would likely be deemed unethical.

Indications

- Premature Infants <30 weeks gestation and/or <1000g
- >30 weeks gestation but unlikely to achieve full enteral feeds by day 5
- Severe intra-uterine growth restriction
- Necrotising enterocolitis
- Gastro-intestinal tract anomalies

General Requirements

Minimal caloric requirements to prevent catabolism are at least 45-60 kcal/kg/day; sick neonates have increased energy requirements
For adequate growth requirements are 100-120kcal/kg/d and at least 3.5g/kg/d protein; if energy intake is restricted basic metabolism will continue but growth will slow. Caloric needs for infants receiving PN are lower, because energy is not needed to cover fecal losses, nor is energy being utilized for the thermogenic effect of food.

What is PN?

PN is an energy rich substrate which can be used until enteral feeds are established. It is usually started at 60mls/kg and increased by 30mls/kg/day until a maximum volume of 150mls/kg/day is achieved. In general PN can be discontinued when a baby is approaching 150mls/kg of enteral feeds. In exceptional circumstances it may be necessary to run PN in

addition to large volumes of feed, eg in post-surgical infants who have poor growth. In other babies it may be necessary to fluid restrict and prescribe a concentrated solution of PN.

PN consists of 2 components:

- Aqueous phase – comprising water, glucose, protein, electrolytes, water soluble vitamins
- Lipid phase– containing fat and fat soluble vitamins

A. Aqueous phase

1. **Glucose** - Dextrose is an essential fuel for infants and is the most important substrate for brain cell metabolism. It provides about 60% of the total energy of PN. The amount of glucose supplied is increased gradually over the first few days of life. Despite this preterm infants may become hyperglycaemic and have glycosuria. If this problem arises the use of an insulin infusion removes the need to decrease the concentration of glucose prescribed. Minimal enteric feeds, with their trophic action on gut hormones also allows a higher concentration of glucose to be tolerated.

2. **Protein** – In the absence of exogenous protein a preterm infant will catabolise 1g/kg/day of protein to meet their metabolic needs. If 1-2g/kg/day of protein (in the form of amino acids) is provided, along with 70kcal/kg/day of non-protein calories, catabolism will be prevented. Recommendations suggest providing up to 4g/kg/day protein to the preterm infant and observational evidence has shown that infants will tolerate this without adverse biochemical (rise in urea, ammonia or amino acids) or clinical consequences. Protein intake should be gradually increased over several days to avoid hyperammonaemia, metabolic acidosis, cholestatic jaundice and plasma acid imbalance.

   Protein, although a potential energy substrate should only be utilised for tissue growth and sufficient glucose and lipid should be supplied to be used preferentially. If insufficient glucose and lipid are available catabolism will occur. The correct balance between non-protein and protein energy must be maintained (25 non -protein kcal; 1g amino acids).
   At present, there is no ideal amino acid solution commercially available solution – at BHH vaminolact (based on breastmilk composition) with low phenylalanine content is used as neonates have limited ability to metabolise this.

3. **Electrolytes –** sodium, potassium, chloride, calcium and phosphate levels need to be closely monitored and prescribed accordingly. There is no requirement for additional sodium in the first 48 hours of life, until diuresis begins. In the extremely preterm infant (<28 weeks) it may be necessary to reduce the chloride content.

   All stages of neonatal PN will have standard amounts of vitamins, minerals and electrolytes suggested. Although bloods are done daily it is not always necessary to alter prescriptions each time and a broad overview of blood results should be taken into account.
   If a baby has an unusual requirement for a particular electrolyte it may be necessary to order tailor made PN (see appendix 4). This must be prescribed by 9am each day and given to the neonatal pharmacist.

4. **Trace Minerals -** a full range of trace minerals and electrolytes are added in Peditrace solution (1ml/kg). This contains: Zinc, manganese, copper, fluorine, iodine and selenium

5. **Water soluble Vitamins -** Solivito N (1ml/kg) containing vitamins B&C is added to the aqueous solution. During administration of PN large quantities of vitamins are lost due to adhere to plastic tubing and biodegradation due to light exposure, therefore greater doses are given to account for this.

B. Lipid (appendix 3)

Lipid is supplied as Intralipid 20% (20g /100mls) (10kcals/g). This is an isotonic fat emulsion that is a concentrated source of energy and the only source of essential fatty acids in PN. After infusion the triglyceride portion is hydrolysed to free fatty acids. Clearance of lipids from plasma is limited by the rate of activity of lipoprotein lipase. 20% intralipid is used as it has lower levels of phospholipids, which is known to inhibit activity of the lipoprotein lipase. However newer alternative sources of lipid are being investigated and may be used in the future.

Lipids are not only a concentrated source of calories, but also provide essential fatty acids for cell membrane integrity and brain development.

Lipid helps to prolong the integrity of peripheral lines because of their lower osmolarity and should be run though the same cannula as the vamin solution. Lipid exposed to light forms potentially toxic lipid hydroperoxides, so lipid syringes and tubing should be protected from light.

Lipid should be started on day 1 of life as studies have shown that a delayed start can lead to essential fatty acid deficiency. Our preterm regimen increases fat intake to 3g/kg/day over 3 days. In the occasional infant a maximum of 4g/kg/day may be required to achieve growth.

Triglycerides are not routinely measured but if there is concern about lipaemic serum a level of <2.0mmol/L should be aimed for.

There is no indication to withhold lipid in septic infants, pulmonary hypertension or those with hyperbilirubinaemia. Historically lipid infusions were completed over 20 hours to allow serum lipid levels to clear in order for analysis of serum electrolytes – this is not a problem with modern analysers.

Vitilip N infant (4mls/kg), containing the fat soluble vitamins (A,D,E & K) is added to the lipid syringe/bag. Lipid stored on the neonatal unit does not have the fat soluble vitamins added, in order to prolong the shelf-life of the solution.

Ordering Parenteral Nutrition

- Parenteral nutrition should be considered in infants <1000g, or in those who are likely to be delayed in achieving full enteral feeds (150mls/kg/day) for >5 days

- Occasionally older babies will require a period of parenteral nutrition, eg in episodes of NEC

- In special cases individual prescriptions can be written for infants with differing amounts of electrolytes, protein and acetate (see appendix 4). These prescriptions must be written and signed by the night registrar by 9am. Special arrangements will be made for Bank holidays.

- The working weight must be used to prescribe PN

- Studies have shown that standardised (maintenance) parenteral nutrition can be used for the majority of infants
- At the present time PN will be started on the second day of life (day 1 or 2).
- Start-up PN bags should be used for days 1 & 2 of commencing parenteral nutrition. These bags have a shelf life of 90 days if refrigerated, and are found on the NNU. If left out of the refrigerator they have a shelf-life of 48 hours. If they are not available the oncall pharmacist should be contacted and bags supplied from pharmacy.
- Lipid syringes may be kept in the neonatal unit fridge. If none are available lipid bags may be available on the unit (not kept refrigerated). If neither are available the oncall pharmacist should be contacted as there will always be lipid in pharmacy which can be supplied.

Start-up Bags (appendix 1)

- Start-up bags are suitable for days 1 and 2. By altering the rate of infusion, the amount of protein, electrolytes and glucose will be altered.
- Start-up bags can be infused for 48 hours* – at a maximum of 60mls/kg on day 1 and 90mls/kg on day 2.

*Manufacturers recommend that infusion lines are changed every 24 hours but it has been decided that the risks of frequent changes of lines and possible infection outweigh the risks of running the solution for 48 hours

Maintenance Bags (appendix 2)

- Maintenance PN is suitable for day 3 onwards and should be prescribed at a maximum of 120mls/kg on day 3 and 150mls/kg for subsequent days.

There are 2 standard maintenance bags – chloride free (A) and chloride based (B).

- For infants < 28 weeks gestation chloride free PN should be used until there is maturation of the renal system. (This will be indicated by a metabolic alkalosis on blood gases).
- In the majority of babies PN will be discontinued before a metabolic alkalosis occurs, however in babies who are on PN for a prolonged period of time a chloride based PN solution should be used. This is also indicated in more mature babies, eg those over 27 weeks gestation.
- Babies transferred from another hospital who have received 48 hours of PN may start on these bags

Tailor Made PN (appendix 4)

- In exceptional circumstances it may be necessary to manipulate the composition of PN to meet the nutritional needs of the infant.
- In babies who are fluid restricted for medical reasons their nutritional intake must not be compromised and it may be necessary to concentrate their PN (appendix 4b)

Administration of PN

A. Infusion Routes

1. **Peripheral route.** This route should be used for short term support (if possible) as PN solution is abrasive to peripheral veins. Peripheral solutions cannot exceed 12.5% dextrose concentration due to the risk of thrombophlebitis.

2. **Central route.** PN should preferentially be given by a central catheter (umbilical venous catheter, long line, surgically inserted central line). The line should be inserted under aseptic technique and the position of the line tip confirmed on xray before use.

B. Connection of PN

TPN is connected using strict aseptic technique. All nursing staff connecting infusions to central lines will have successfully completed their assessment on the use of central lines. No additions will be made to the PN solution on the neonatal unit.
Appropriate filters should be used during the administration of PN because of the large volume of potentially particulated contaminated fluid administered and their increased susceptibility to the detrimental effects of particulate contamination.
Lipid filters should also be used.

C. Weaning PN

When advancing enteral feeds, reduce the rate of PN administration to achieve desired total fluid volume; for each 0.5mls/hr reduction decrease the aqueous solution by 0.4ml/hr and the lipid by 0.1ml/hr. A small amount of lipid must continue to be infused until the aqueous solution is completely stopped. PN should continue until enteral nutrition is providing at least 75% of nutritional requirement.
Always assess the nutrient intake from both PN and enteral feeds in relation to the overall nutritional goal

Complications

A. Delivery

The line delivering the PN may be compromised by:
Sepsis – coagulase negative staphyloccus infection is associated with presence of central lines and treatment of positive blood cultures with vancomycin may be necessary, or even removal of the line.
Malposition – the position of the line tip should be confirmed by xray and documented in the medical notes before use
Thrombophlebitis – which is mainly a problem with peripheral PN
Extravasation - into soft tissue requiring irrigation with hyaluronidase

B. Metabolic Complications

Hyperglycaemia – this can be controlled with an insulin infusion. Consideration must be made that hyperglycaemia is not a symptom of another condition, eg sepsis.
Hyperlipidaemia – this is an uncommon condition and may necessitate decreasing the amount of lipid supplied.
Cholestasis – this is well recognised and is believed to be multi-factorial. Typically it only is present when there has been prolonged PN use. It manifests itself with rising serum bilirubin, with an increased conjugated fraction and is a diagnosis of exclusion.
Metabolic bone disease- careful monitoring of calcium and phosphate will minimise the chance of metabolic bone disease/ osteopaenia of prematurity and the risk of rickets and fractures.

Drugs and PN

Drugs should not routinely be infused with PN but sometimes this is unavoidable. In special cases advice should be sought from pharmacy.

Monitoring

1. Laboratory – daily FBC, U&E, bone profile, LFTs until stable; babies on PN for greater than 4 weeks will need measurement of selenium, zinc, copper and iron

2. Blood sugar – 4-6 hourly Medisense first 3 days and then twice daily

3. Clinical – daily weight, weekly head circumference

Appendix 1

Standard Bags – suitable for day 1 & day 2 (glucose concentration 10-11%)

	Prescription volume mls/kg	Vamin volume mls/kg	Glucose g/kg	Protein g/kg	Nitrogen g/kg	Na mmol/kg	K mmol/kg	Ca mmol/kg	PO4 mmol/kg	Mg mmol/kg	Zn mcmol/kg	Cl	Acetate	Total energ kcal/kg
Day 1	60	55	6	1.65	0.23	0	0.55	0.55	0.55	0.11	2.2	0	0	28
Day 2	90	80	8	2.4	0.34	0	0.8	0.8	0.8	0.16	3.2	0	0	40.8

Appendix 2

Maintenance Bags – suitable for day 3 & onwards (glucose concentration 9-11%)

A – **Chloride free** – suitable for babies <28 weeks or those with persistent metabolic acidosis on blood gas

	Prescriptio n volume mls/kg	Vamin volume mls/kg	Glucose g/kg	Protein g/kg	Nitrogen g/kg	Na mmol/kg	K mmol/k g	Ca mmol/kg	PO4 mmol/kg	Mg mmol/kg	Zn mcmol /kg	Cl	Acetate	Total e kcal/k
Day 3	**120**	**105**	**11.7**	**2.7**	**0.39**	**2.36**	**1.58**	**1.2**	**1.2**	**0.16**	**0**	**0**	**1.58**	**56.6**
Day 4	**150**	**135**	**12**	**3.11**	**0.44**	**2.7**	**1.8**	**1.4**	**1.4**	**0.18**	**0**	**0**	**1.8**	**65.4**

B - Chloride based – suitable for babies >27 weeks gestation or those >7 days

	Prescription volume mls/kg	Vamin volume mls/kg	Glucose g/kg	Protein g/kg	Nitrogen g/kg	Na mmol/kg	K mmol/k g	Ca mmol/kg	PO4 mmol/kg	Mg mmol/kg	Zn mcm ol/kg	Cl	Acetate	Total kcal/k
Day 3	120	105	11.7	2.7	0.39	2.36	1.58	1.2	1.2	0.16	0	1.6	1.58	56.6
Day 4	150	135	12	3.11	0.44	2.7	1.8	1.4	1.4	0.18	0	1.8	1.8	65.4

Appendix 3

Lipid Infusion

	Lipid prescription g/kg	Lipid Rate ml/kg
Day1	1	5ml
Day 2	2	10
Day 3	3	15ml

Energy content

	Kcal/g
Protein	4
Glucose	3.4
Lipid	10

Appendix 4

BIRMINGHAM HEARTLANDS HOSPITAL INDIVIDUALISED NEONATAL PN PRESCRIPTION

THIS PRESCRIPTION SHOULD ONLY BE USED IF START-UP AND MAINTENANCE BAGS ARE NOT SUITABLE FOR THE NUTRITIONAL REQUIREMENT OF THE INFANT

Name	**PID No**	**DoB**	**Working Weight (kg)**	**Consultant**

Are Start-up bags prescribed? **Y/N** (delete as appropriate).If Y start prescribing on appropriate day

Date	**Batch Number/ Expiry date**	**Doctors signature**

Route: peripheral/central (delete as appropriate)	**P/C**	**P/C**	**P/C**	**P/C**	**P/C**	**P/C**	**P/C**
Total fluid intake (ml/kg)	60	90	120	150	150	150	150
Total TPN intake (ml/kg)							
Date	***…/…/.***	***…/…/.***	***…/…/.***	***…/…/.***	***…/…/.***	***…/…/.***	***…/…/.***
Regimen	**A**	**A**	**B**	**B**	**B**	**B**	**B**
Requirements/kg							
mmol of Sodium	3	3	3	3	3	3	3
mmol of Potassium	2.5	2.5	2.5	2.5	2.5	2.5	2.5
mmol of Calcium	**1**	1	1	1	1	1	1
mmol of Phosphate	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Any changes to above (e.g. % glucose in aqueous phase, chloride restrictions, maximum phosphate)							
Prescriber signature							
Bleep number/telephone							
Pharmacist signature							
Bleep number/telephone							

The figures in faint type are for suggestion only. If these boxes are not completed the prescription will be returned to the Neonatal Unit

BIRMINGHAM HEARTLANDS HOSPITAL INDIVIDUALISED NEONATAL PN PRESCRIPTION CONTINUATION SHEET

THIS PRESCRIPTION SHOULD ONLY BE USED IF MAINTENANCE BAGS ARE NOT SUITABLE FOR THE NUTRITIONAL REQUIREMENT OF THE INFANT

Name	**PID No**	**DoB**	**Working Weight (kg)**	**Consultant**

Route: peripheral/central (delete as appropriate)	**P/C**	**P/C**	**P/C**	**P/C**	**P/C**	**P/C**	**P/C**	**P/C**
Total fluid intake (ml/kg)	150	150	150	150	150	150	150	150
Total TPN intake (ml/kg)								
Date	***…/…/.***	***…/…/.***	***…/…/.***	***…/…/.***	***…/…/.***	***…/…/.***	***…/…/.***	***…/…/.***
Regimen	**B**	**B**	**B**	**B**	**B**	**B**	**B**	**B**
Requirements/kg								
mmol of Sodium	3	3	3	3	3	3	3	3
mmol of Potassium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
mmol of Calcium	1	1	1	1	1	1	1	1

mmol of Phosphate*	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Any changes to above (e.g. % glucose in aqueous phase, chloride restrictions, maximum phosphate)								
Prescriber signature								
Bleep number/telephone								
Pharmacist signature								
Bleep number/telephone								

The figures in faint type are for suggestion only. If these boxes are not completed the prescription will be returned to the Neonatal Unit.
If it is anticipated the neonate requires TPN for longer than 14 days, monitoring of the electrolytes associated with trace elements (Copper, Selenium, Zinc, Iron) should be performed

BHH NEONATAL INDIVIDUALISED PN GUIDANCE FOR PRESCRIBING

Regime		Nitrogen g/kg	Protein g/kg	Glucose g/kg	Energy kcal/kg
A	Day 1 (60mls/kg)	0.23g/kg	1.65	6	28
	Day 2 (90mls/kg)	0.34g/kg	2.4	8	40.8
B	Day 3 (120mls/kg)	0.39g/kg	2.7	11.7	56.6
	Day 4 (150mls/kg)	0.44g/kg	3.11	12	65.4
C	Day 4 (100-120mls/kg)	0.44g/kg	3.11	12	65.4

Day 1 & 2 solutions (A) contain identical amounts of protein & glucose
Day 3 & 4 solutions (B) contain identical amounts of protein & glucose
In certain cases it may be necessary to restrict the volume of fluid to 100-120mls/kg. In these babies on day 4 regime C must be prescribed, which will give optimum nutrition in a restricted volume of fluid

Electrolytes

These should be prescribed daily according to recent U & E's. Typical daily requirements to maintain biochemistry are:-

Sodium **3** (2-8) mmol/kg Calcium **1** (up to 3) mmol/kg
Potassium **2.5** (1-6) mmol/kg Phosphate **1** (up to 3) mmol/kg
Magnesium **0.2**mmol/kg

- *If limits beyond the figure range in brackets are to be considered please consult the admitting consultant in the first instance.*

- The aqueous bag contains chloride salts of 2.8mmol/kg on average. For neonates born less than 28 weeks gestation a chloride-free TPN should be considered. Write this request in the *changes* box on the prescription chart

- If possible prescribe PN for 48 hours

Supplements
Peditrace: 1ml/kg
Solivito N: 1ml/kg
Vitlipid N Infant: 4ml/kg

Peditrace, each 1ml contains		Solivito N. When reconstituted to 10ml, each ml contains		Vitlipid N infant, each ml contains	
Zn^{2+}	3.82 micromol	Vitamin B_1	250 micrograms	Vitamin A	69 micrograms
Mn^{2+}	18.2 micromol	Vitamin B_2	360 micrograms	Vitamin D_2	1 microgram
Cu^{2+}	0.315 micromol	Nicotinamide	4mg	Vitamin E	640 micrograms
F	3 micromol	Vitamin B_6	400 micrograms	Vitamin K_1	20 micrograms
I	7.88 micromol	Pantothenic acid	1.5 mg		
Se^{2+}	25.3 micromol	Biotin	6 micrograms		
		Folic Acid	40 micrograms		
		Vitamin B_{12}	0.5 micrograms		
		Vitamin C	10 mg		

PN is manufactured Monday to Friday by Hospira Healthcare. The prescriptions should be with the pharmacist before 9am and faxed to Hospira before 10.30 am to ensure same day delivery.
TPN prescriptions and bags are checked by two members of pharmacy staff before faxing and on receipt in pharmacy. For statutory holidays contact the ward pharmacist to discuss supply.

- Each prescription sheet covers seven days. When greater than a week of TPN is required use a continuation sheet. If there is a weight increase, complete the continuation sheet with such detail.
- All calculations are based on the WORKING weight.
- DO NOT MAKE ANY ADDITIONS TO THE BAGS OR SYRINGES
- If it is anticipated the neonate requires TPN for longer than 14 days, monitoring of the electrolytes associated with trace elements should be performed.

Stages of feed

- Start all babies on a day 1 regimen. The Start-up bag (kept on NNU) has similar protein and glucose content also based on a day 1 regimen and can be initiated after the ordering time from Hospira has been exceeded and for weekend requirements. The lipid is supplied as a separate source (in a syringe or infusion bag according to fluid requirements). The Start-up bag can be administered for up to 48 hours as long as electrolyte requirements are stable
- There are no vitamins or trace elements in the stock bag.

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Crash Calls

How to put out a Crash Call:

Dial 2222 and say "Neonatal Emergency on *<give the location>*"

The crash bleep holders will be fasted bleeped receive a message from switchboard saying:

"Neonatal Emergency on < *location*>"

The "Neonatal crash call group" consists of a neonatal SHO, a neonatal SpR, a general paediatric registrar and an ANNP or senior neonatal nurse.

When both the neonatal and the general paediatric registrar are in the hospital, only the neonatal registrar will attend crash calls in the Maternity Unit. If he/she leaves the hospital, the remaining registrar **must** be aware of this and **must** attend neonatal crash calls until the neonatal registrar returns

It is the responsibility of the SHO and the Registrar to check that their individual crash bleeps are working. They are tested twice daily at 10.00 and 22.00 by switchboard.

An SHO's ANTICIPATION of trouble (e.g. a foot presentation at 25 weeks) may result in the SHO crash calling the registrar in order to ensure that more senior help is immediately available.

Flying Squads

Home Births

- This NNU does NOT have a flying squad to go out and collect babies born at home.
- **Ambulance crews** called to births at home have clear instructions to summon a midwife if help is needed, NOT a doctor.
- **Community Midwives** have clear instructions to perform basic resuscitation and then pick up the baby born at home and bring him/her to NNU for further care if needed.

Crash bleeps

- The BHH Neonatal SHO on call page **2143** is on The Neonatal Emergency Group only
- The BHH Neonatal SpR on call page **2922** is on both Paediatric Emergency / Arrest and Neonatal Emergency Groups

- The BHH Paediatric SpR on call page **2923** is on both Paediatric Emergency / Arrest and Neonatal Emergency Groups

Staff are distributed like this so that a neonatal SpR and SHO are crash bleeped simultaneously to any neonatal emergency. When the neonatal registrar is out of the hospital he/she can tell the general paediatric SHO who will attend neonatal crash calls (with the SHO) until the neonatal SpR returns.

Notes:

- Neonatal Doctors are sometimes referred to as Paediatrics/paediatricians. Encourage / remind labour ward and NNU staff to call you the "Neonatal SHO / Registrar".

- If a request is received via 2222 or sometimes via 0 for a person to be **fast paged** the Operator will **individually** page the person requested, only one person will receive notification. The pager will be activated using a different tone (faster) than a normal paging call.

- If a request is received via 2222 or sometimes via 0 for a person to be **crash paged** the Operator will page the appropriate Group e.g. Neonatal Group or Obstetric Group. All members of that group will be notified simultaneously and receive notification of the incident/ request.

- The groups are programmed to take priority over all other calls. If a call is made via 2222 the call is received by the operator on a specific phone which will be answered in 1 or 2 seconds. If someone dials 0 the call goes into an operator queue and can take significantly longer to answer.

- If you need an urgent cross match of blood (e.g. baby born shocked and anaemic), then "Emergency Bleep (2222) and request Rapid Carrier Porter for Massive Bleed." and give your location (see also haematology section)

Accepting babies for intensive care

Background:
The unit has 5 intensive care cots that are occupied as fully as possible. Cots are equally available to Heartland babies and other babies throughout the region, and cots cannot be "saved" for Heartland babies to the detriment of other babies in other hospitals.

An intensive care cot should not be closed without consultant agreement.
However, a cot may be reserved for already accepted in-utero transfers and Heartland booked babies when preterm delivery at less than 31 weeks is anticipated within 24 hours.

In-utero transfers: **A Prompt and Definite Reply is Needed**

If telephoned about a potential in-utero transfer, the staff member of the NNU must:

1. Check with the nurse in charge (and a doctor if appropriate) if an ITU cot is available. The consultant and the nurse in charge will have agreed this at the end of the morning round.

2. Advise the caller whether we have space or not.

3. Make sure the caller contacts our obstetric registrar on-call to arrange the transfer of the mother. Make it clear that the obstetricians and midwives arrange the transfer, not the NNU.

Post-natal transfers: **A Prompt and Definite Reply is Needed**

The referring doctor may be working under difficult circumstances!

1. Check with the nurse in charge (and a doctor if appropriate) if an ITU cot is available. The consultant and the nurse in charge will have agreed this at the end of the morning round.

2. Advise the caller whether we have space or not. Give them your name.

3. Assuming we have space - if the neonatal registrar or consultant is on the unit, call them to the phone to discuss details with the referring doctor.

4. If there is no senior doctor on the unit, tell the referring doctor again that we will accept the baby and obtain the following details in the transfer book:

Hospital	Doctor's name	Reason for transfer
Telephone number	SCBU Extension number	
Mother's surname	Birthweight	Gestation
Apgar Scores	BMs/Medisense reading?	? Had surfactant
Summary of present condition		

5. Tell the doctor that the mother's transfer is to be arranged separately by the obstetricians.

6. Contact our neonatal registrar immediately.

7. The registrar and senior nurse are responsible for contacting the retrieval team.

Retrieving and returning babies:

Contact the network transport team on **07929 053 730** (use first) or **07929 053 660**

Revised MW May 2010

Labour ward resuscitation of term and preterm babies

A Registrar or Staff Grade doctor or Consultant must attend deliveries of < 29 weeks gestation. This may involve giving up to 30 minutes warning to allow time for the doctor to reach labour ward.

Paediatric SHOs / ARNBs / ANNPs **must** attend the following:

1. All Caesarean Sections under general anaesthetic
2. All breech presentations
3. All multiple deliveries
4. All preterm deliveries < 36 completed weeks gestation
5. All deliveries with fetal distress:
    a) meconium (but not Grade 1 meconium if all else is well)
    b) type II dips
    c) scalp pH < 7.2
6. All babies with a suspected congenital abnormality, which may cause immediate problems
7. Babies born to HIV mothers.

They should be aware of:

1. Other Caesarean sections
2. Infants of diabetic mothers
3. Infants of mothers with Rhesus antibodies
4. Mothers with a pyrexia
5. Mothers with prolonged (> 24 hours) rupture of membranes
6. Mothers known to be colonised with Group B Streptococcus

Paediatric SHOs may be involved with these babies soon after birth, even if they do not attend the delivery. The topics are dealt with separately.

SHO guidelines for calling a registrar or staff grade doctor or consultant to be present at a delivery

	Registrar or Staff Grade	**Consultant**
SHO deliveries * for first 2 - 3 weeks	Yes	*If called by registrar or staff grade doctor*
Babies of 24 to 28 weeks	Yes	*If called by registrar or staff grade doctor*
Babies at 23 weeks gestation	Yes	Yes
Babies with suspected lethal abnormalities	Yes	If agreed in advance
Babies with severe asphyxia, hydrops etc	Yes	If called by registrar or staff grade doctor

Resuscitation of very preterm babies.

ANNP & SHO guidelines for calling a registrar or staff grade doctor or consultant to be present at a delivery

	Registrar or Staff Grade	**Consultant**
SHO deliveries * for first 2 - 3 weeks	Yes	*If called by registrar or staff grade doctor*
Babies of 24 to 28 weeks	Yes	*If called by registrar or staff grade doctor at BHH,* always *at Good Hope.*
Babies at 23 weeks gestation	Yes	Yes
Babies with suspected lethal abnormalities	Yes	If agreed in advance
Babies with severe asphyxia, hydrops etc	Yes	If called by registrar or staff grade doctor

Guidelines for the care of women in established labour at 20-23 weeks

Women with a pregnancy of $\geq$ 20 weeks will be cared for on the Maternity Unit. These guidelines deal with the care of women at 20-23 wks gestation if labour is established and delivery inevitable.

(1) On admission the obstetric registrar is informed

(2) **When established labour is diagnosed and gestation confirmed as 23 weeks and above, the Paediatric registrar is informed and management of the case agreed by both teams.**

(3) If unbooked and/or gestation is uncertain, the Paediatric registrar will be present at birth. The plan for active resuscitation will be followed unless the baby is **very** immature and weighs < 450g at birth.

(4) The plan of management is discussed with the parents by the obstetrician and recorded in the mother's case notes.

The management planned ante-natally will fall into one of the following categories:

(1) No active resuscitation of the baby
(2) Termination of pregnancy for fetal abnormalities
(3) Active resuscitation of the baby

(1) No active resuscitation

(a) No monitoring
(b) Choice of appropriate analgesia
(c) Nursed in 'low tech' rooms (monitoring and resuscitation equipment removed).
(d) At all times appropriate and sensitive support is given to the woman and her partner. It is important that the parents understand that the baby may gasp or breathe for a considerable period of time after delivery.
(e) The paediatrician will not be present at delivery.
(f) The baby is dried, wrapped in a blanket and given to the parents to hold. He/she will stay with the parents either on the Labour Ward or on the post-natal ward (bereavement room) until there are no signs of life - unless otherwise requested.
(g) Follow guidelines for bereaved parents, including requesting a post-mortem.

(2) Termination of pregnancy for fetal abnormality.

(a) The place for delivery should be in conjunction with the parents' wishes.
(b) The timing of induction will be discussed with the parents.
(c) Nursed in 'low tech' rooms (monitoring and resuscitation equipment removed).
(d) Appropriate analgesia.
(e) The baby is dried, wrapped in a blanket and given to the parents to hold. He/she will stay with the parents either on the Labour Ward or on the post-natal ward (bereavement room) until there are no signs of life - unless otherwise requested.
(f) Follow guidelines for bereaved parents, including requesting a post-mortem.

3) Active resuscitation at 23 weeks

(a) No continuous electronic monitoring.
(b) Intermittent auscultatory monitoring.
(c) Appropriate choice of analgesia.
(d) Nursed in delivery room with appropriate equipment.

(e) Pay attention to thermal environment. Activate Transwarmer mattress before birth. Ensure heater on at 100% but ready to change to Servo set to 37°C.
(f) Consultant paediatrician, Registrar **and** SHO to be at delivery
(g) NNU nursing staff to be present with intensive care transport incubator.

Resuscitating Babies of 23 weeks gestation

A consultant and registrar are to be present

If gestational age is ***certain*** at 23+0 – 23+6 (i.e. at 23 weeks) and the fetal heart is heard during labour, a professional experienced in resuscitation should be available to attend the birth. In the best interests of the baby a **decision not to start resuscitation is an appropriate** approach particularly if the parents have expressed this wish.

- Place the baby in a pre-warmed and opened plastic bag (see guidelines)
- Weigh the baby before placing on the resuscitaire:
- Do not resuscitate if both 23 weeks and < 450g
- Do not resuscitate if no heart beat at birth

- Place on a "Transwarmer mattress". Keep the baby as warm as possible: hypothermia is a life threatening complication. Apply a temperature probe under the arm and set the heater to "Servo" with a set temperature of 37°C.

- INTUBATE THE BABY and ventilate. Apply the pulse oximeter. Be familiar with normal heart rate and oximetry readings in preterm babies. Note the 50th centile at 3 minutes is < 75% saturation.
- Endotracheal tube length for emergency intubation (NB these figures correspond closely with this given on the graph in the ventilation section).

Gestation (Wks)	ETT at lips (cm)		Gestation (Wks)	ETT Length at lips (cm)
23-24	5.5		33-34	7.5
25-26	6.0		35-37	8.0
27-29	6.5		38-40	8.5
30-32	7.0		41-43	9.0

Initially use 40% oxygen and then, using the blender, reduce the FiO_2 while maintaining the saturations in the normal range (> 70% after 7 minutes), though > 90% of babies will need some oxygen.

NORMAL OXIMETRY and OXIMETRY HEART RATE DATA
(Dawson JA et all. Arch Dis Child Fetal & Neonatal Ed 2009:94:F87-F91)

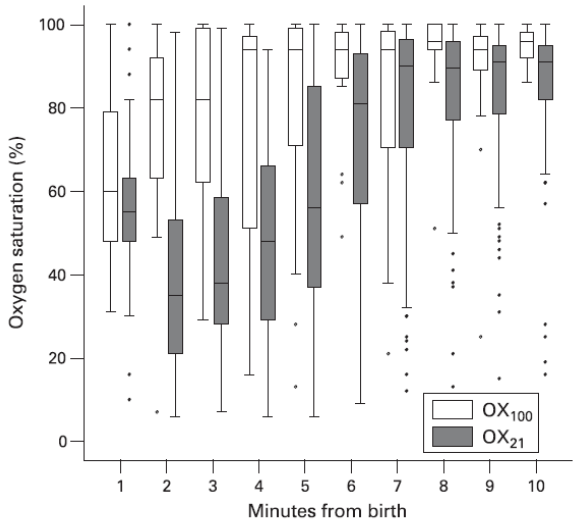


Figure 2 Spo_2 shown at each minute, for the first 10 min after birth, from the group receiving 100% oxygen (OX_{100}) and the group receiving 21% oxygen (OX_{21}). The box plots show the median, interquartile range, normal range and outliers. Small circles indicate outliers.

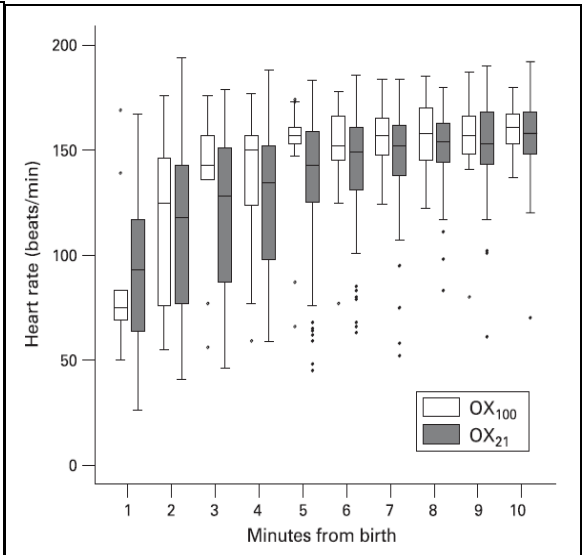


Figure 3 The heart rate shown at each minute, for the first 10 min after birth, for infants from the 100% oxygen (OX_{100}) group and the 21% oxyen (OX_{21}) group. The box plots show the median, interquartile range, normal range and outliers. Small circles indicate outliers.

- If good air entry and HR > 100, secure tube, give Curosurf either at 200mg/Kg or the whole vial (120mg in 1.5ml) if the baby weighs > 600g and transfer to NNU.

- If bradycardic and tube definitely in the trachea – not the oesophagus, not the right main bronchus – give long inspiratory times (3 to 5 seconds) at adequate pressure (up to 30cm H_2O) to achieve a functional residual capacity.

- If you cannot intubate, consider applying CPAP through a pre-lubricated short nasal tube (2.0 Vygon cut to 6 cm) closing the contralateral nostril and lips to ensure tight seal. ENSURE THAT A MORE SENIOR COLLEAGUE HAS BEEN CRASH CALLED.

- If response poor or absent either stop at this point, or - depending on the consultant's clinical assessment - give external chest compressions and adrenaline.

- If response still poor or absent, stop resuscitation.

- At all times, one member of the team should keep the parents informed.

Resuscitating very preterm babies between 24+0 and 29+6 weeks

CPAP IS THE PREFERRED MODE ABOVE 26+0 WEEKS

a) **ANNP / SHO + registrar or consultant + neonatal nurse to attend delivery (At Good Hope, a consultant should attend these deliveries).**
b) If unplanned, ANNP / SHO + senior nurse to attend
c) If unexpected, ANNP / SHO will be at delivery - should crash call for help immediately.
d) Resuscitate all babies > 23^{+6} weeks gestation (see above for 23 weeks).

e) If delivery is at < 26+0 weeks, intubate, give Curosurf either at 200mg/Kg or the whole vial (120mg in 1.5ml) if the baby weighs > 600g and transfer to NNU. Monitor temperature, saturations and heart rate as above. Follow NLS algorithm.

f) If delivery is between 26+0 and 30+0 weeks gestation, observe the baby to assess the respiratory effort and heart rate:

- If the baby is vigorous with minimal recession, do not intervene except to establish temperature and oximetry monitoring. (About 20% of babies will achieve this.)

- If the baby has a modest respiratory effort and a heart rate > 60, apply 8 cm (**eight** cm) of CPAP through a pre-lubricated 6 cm Vygon tube in one nostril , closing the other nostril and mouth to ensure a good seal. If the response is poor, give 5 inflation breaths (3 seconds) at 20cm H_2O through the tube and repeat the CPAP. **Use 40% oxygen initially.**

- If the baby is apnoeic and/or shocked, give 5 inflation breaths either via a mask or the short 6 cm Vygon tube and continue NLS resuscitation until the baby has a good spontaneous respiratory rate. Apply CPAP at 8 cm again and re-assess whether immediate intubation is needed.

- If intubated, **use 40% oxygen initially,** achieve saturations in the target range, then prepare and administer surfactant on Labour Ward.

g) Obtain 10ml maternal serum for cross matching - see transfusion guidelines.

Transferring babies to NNU

Babies may be transferred either:

1. On the resuscitaire with the lead resuscitator maintaining either IPPV or CPAP and monitoring the baby during transfer or
2. In the transport incubator ventilated or on CPAP from the integral ventilator, and with appropriate monitoring. *This is the method of choice at Good Hope.*

Whichever method is used security of the airway, heart rate monitoring and good thermal care must be maintained.

Wrapping babies < 30 weeks gestation in bags and using Transwarmer mattresses

Hypothermia is a problem in preterm babies

- It is an independent risk factor for death and oxygen dependency
- To reduce the heat loss that babies < 30 weeks gestation suffer -
  a) all such babies will be placed in a polythene bag **immediately** after birth - see drawings.
  b) place the baby on a Transwarmer mattress

c) be constantly vigilant over the thermal care of the baby: monitor the temperature and use the resuscitaire's Servo controls to maintain normothermia (36.5 to 37.5^{o}C).

LABOUR WARD - when the birth of a baby < 30 weeks gestation is anticipated:

- Ensure the resuscitaire has a blender, **and start with it set at 40%**
- Ensure temperature servo sensor is ready.
- Ensure pulse oximeter is ready
- Prepare a plastic bag (so there is no struggle to open it when the baby is born)
- WARM it under the radiant heater of the resuscitaire
- Ensure a Transwarmer mattress is available to be activated before birth: it will stay warm for more than 30 minutes.
- Ask for the cord to be left long
- The baby will be handed to you with a cord clamp in place
- **Place the baby in the bag up to the baby's neck. Dry and cover the head with part of the bag or put on a woollen hat.** Do not dry the baby's body.
- Place the wrapped baby under the resuscitaire on the activated Transwarmer mattress and apply the oximeter and temperature probe.
- Proceed with any necessary resuscitation as normal, but with the baby in the bag
- Do not open the Curosurf unless the baby is intubated, at which point it should be given- either at 200mg/Kg or the whole vial (120mg in 1.5ml) if the baby weighs > 600g. If the baby is intubated and ventilated later on NNU, give Curosurf promptly then
- If you have to insert an umbilical line on labour ward, cut the bag so as to expose the umbilicus only. Do not take the baby out of the bag. Put a woollen hat or polythene wrap on the head.
- If on CPAP, wrap the bagged baby in warmed blankets, and transfer to NNU on the resuscitaire with the lead resuscitator maintaining the airway and CPAP. Place on CPAP on the NNU.

- If ventilated, transfer in the transport incubator and ventilate on NNU.

On NNU

- Weigh the baby in the bag if not weighed on labour ward
- Place the bagged baby on the Transwarmer mattress under the Airshields radiant heater or in a closed incubator
- Ventilate or give CPAP as appropriate
- **Remove the bag ONLY when the baby's temperature is 36.5^{o}C or above and when you are ready to site monitor leads and/or set up drips, take bloods etc**
- **Dry the baby**

Special groups of babies.

Preterm and low birth weight.

Keeping warm is an issue:

Ask for theatre/delivery room temperature to be increased: WHO recommends 25^{o}C as a minimum
Work under overhead heater in draught free area
Wrap in a plastic bag without drying if < 30 weeks
Consider using a Transwarmer mattress at < 30 weeks
Change wet sheets for warm dry ones
Keep exposure to minimum
Give surfactant on labour ward if intubated and < 30 weeks
Use transport incubator if very small and/or if delays
Bring to NNU soon: Let parents hold first if possible

Endotracheal tubes

The tubes kept on Labour Ward for resuscitation are the Portex shouldered endotracheal tubes. They are tubes with blue adaptors that fit straight onto the T-piece used for resuscitation.

The green Vygon tubes can also be used for resuscitation if long term ventilation is certain (e.g. at 25 weeks) but they are not stored on Labour Ward. They might also be used in babies < 30 weeks as surfactant should be administered on Labour ward if a baby of this gestation is intubated. An introducer may be needed for these softer tubes for endotracheal intubation (but not short tube nasal CPAP). If only a Size 2 ETT can be passed, the plastic cover of the metal introducer will have to be stripped off in order for it to go into a size 2 ETT. Cut circumferentially around the plastic cover and it will slide off easily. Under no circumstances should the tip of any introducer protrude beyond the end of the ETT, as it can penetrate the trachea and mediastinum.

All CPAP for resuscitation must be given through a 2.0 Vygon tube cut to 6 cm and placed in one nostril with the other nostril and mouth held closed

If a larger baby unexpectedly needs continuous ventilation or CPAP from birth, the resuscitaire can be unplugged, run off oxygen cylinders at the back, and wheeled in the NNU whilst **controlled** ventilation/CPAP continues.

Intubation, ventilation and surfactant
The need for intubation is reduced by proficient mask ventilation in babies of all gestations. Be sure you have been shown the technique using a T-piece and mask. Perhaps as few as 0.2% of babies need intubation at birth

After intubation, **suck out ETT first only if there is meconium or blood or copious lung fluid**.

Tube size:	Size 3.5 for babies > 4.5kg	(Tubes in store on labour ward)
	Size 3.0 for babies > 31 weeks	
	Size 2.5 for babies > 24 weeks	

Initial pressures:	not above 30 cms H_2O, use less particularly in prems if possible.
5 Initial breaths:	3 seconds long to achieve functional residual capacity
Later ventilation breaths:	upto 1 second long, shorter if good response
Leave tube in	while baby develops regular respiration
Suck out	oro-pharynx and trachea before extubation

Keep warm

All babies <30 wks gestation *who are intubated for resuscitation* should get surfactant on Labour Ward

Audit measures:

The following parameters should be considered when auditing the outcome of resuscitation of preterm babies < 30 weeks:

- Mortality
- CLD
- % intubated on either Labour Ward or the NNU and age at intubation
- FiO_2 at 5 mins
- Pneumothoraces and other air leaks
- Surfactant use – time of administration

BAPM framework for clinical management of very preterm babies

Below is the text from Management of babies born extremely preterm at less than 26 weeks of gestation: a framework for clinical practice at the time of birth by Wilkinson at al that has been endorsed by BAPM **.** Our own brief guidelines comply with this, but the paper should be read in full. The Nuffield Council published a report on the Ethics of caring for very preterm babies. All staff should read this: it is available on-line at: http://www.nuffieldbioethics.org/go/browseablepublications/criticalCareDecisionFetalNeonatalMedicine/report_498.html

Management of the delivery of an extremely preterm baby is one of the most challenging aspects of perinatal medicine. The ethical, social, economic and legal issues have recently been reviewed by the Nuffield Council on Bioethics. The professions and advocates for parents were encouraged to consider the pattern of care appropriate for babies born before 26 weeks' gestation on the basis of the best information currently available. There are limitations to contemporary evidence, particularly in terms of predicting outcome after the shortest of pregnancies. While recognising these limitations, and although every pregnancy is different, some general principles can be described. This is not a set of instructions, but a framework to highlight the range of evidence and opinion that needs to be considered by staff and parents. Care of the mother, her fetus and the baby will always need to be individualised and should be led by senior staff in all disciplines. The parents' hopes and expectations need to be explored with honesty and compassion in a realistic way, drawing upon the available evidence. Communication and agreed plans must be documented in full and signed legibly. These plans may need to be revised frequently.

BEFORE DELIVERY: When it appears that a mother will deliver her baby at a very early gestational age, there is important clinical information that needs to be carefully reviewed. Accurate information will greatly assist the dialogue and inform the decisions made. Whenever possible antenatal management decisions should involve both of the parents and the clinical staff who will be responsible before and after the delivery. The obstetric history and antenatal care must be considered carefully, with particular attention to the ultrasound dating scan(s). The earlier this has been carried out the more accurately the gestational age will be known.2 Other information about fetal growth or abnormalities may be available from the scan(s). The best estimation of gestational age should be agreed with the parents. A record of the discussion must be made and revised according to any changes in condition of the fetus or mother. Discussion with the parents must include information about the expected outcome based on the best available local and national population data. Care must be taken in interpreting local hospital statistics which, at very low gestational ages, will be based on small

numbers even in the largest centres. The practicalities of starting, withholding and withdrawing intensive care and the positive role of palliative care where appropriate should be described to the parents. This will help to prepare them for the different possible outcomes after delivery. Parents may find the advice and support of their family, friends and spiritual advisers to be of great value at this time. Assessment of the local neonatal unit staffing and capabilities must be made. Transfer to another hospital, increasingly likely within a managed clinical network, should be discussed if this is clinically appropriate. Written information that includes this possibility should be given to all parents at the time of booking. If time allows, the parents should be offered the opportunity to visit the neonatal unit.

MANAGEMENT RECOMMENDATIONS: On the basis of the best assessment of gestational age, as well as information about the well-being of the fetus and the wishes of the parents, a clear plan for delivery and care of the baby must be made and documented. This will need to be reviewed regularly. Discussion about the mode of delivery should include an explanation of the maternal morbidity in future pregnancies associated with a classical caesarean section when carried out at very early gestational age. However, this may be necessary for maternal indications. If active obstetric intervention in the interests of the fetus is not planned, continuous monitoring of the fetal heart rate is not advised. However, the parents should be made aware that their baby may show signs of life for a variable time after birth, and intermittent assessment of the fetus by a Doppler device or auscultation is useful to the professionals responsible at the time of birth.

RESUSCITATION AT BIRTH: Preterm labour often progresses rapidly. In these circumstances, there may be insufficient time to hold a detailed discussion with the parents before the baby is born. A decision about resuscitation may need to be made on the basis of the most recent management plan, if any, and the available clinical information. When lung inflation with a mask is an appropriate initial approach, this should be carried out as described in the Newborn Life Support course handbook.

A FRAMEWORK FOR CLINICAL PRACTICE: This was developed on the basis of consensus and the most recent evidence available.

(A) Less than 23^{+0} weeks

If gestational age is certain and less than 23+0 (ie, 22 weeks), it would be considered in the best interests of the baby, and standard practice, for resuscitation not to be carried out. If the parents wish, they should have the opportunity to discuss outcomes with a second senior member of the perinatal team. In the EPICure study of all babies born in 1995 in the UK and Eire at ,26 weeks' gestational age, only two babies reported on at ,23 weeks survived to discharge and one has severe disability. In the EPICure 2 study (2006), survival remains extremely rare at this gestational age, with a high incidence of early major morbidity in the few who are discharged home.7

(B) 23^{+0}–23^{+6} weeks

If gestational age is certain at 23^{+0}–23^{+6} (ie, 23 weeks) and the fetal heart is heard during labour, a professional experienced in resuscitation should be available to attend the birth. In the best interests of the baby, a decision not to start resuscitation is an appropriate approach, particularly if the parents have expressed this wish. However, if resuscitation is started with lung inflation using a mask, the response of the heart rate will be critical in deciding whether to continue or to stop and sensitively explain to the parents the futility of further interventions. The EPICure study (1995) reported in 2000 that, at 23 weeks, 21/241 (50%) of live born babies were admitted for intensive care, of whom 105 (80%) died in hospital. Twenty-six babies were discharged home, one died and 14 (54%) have a moderate or severe disability at 6 years of age. Early findings in the EPICure 2 study (2006) show that, at this gestational age, survival has not increased significantly and there has been no change in early major morbidity.

(C) 24^{+0}–24^{+6} weeks

If gestational age is certain at 24^{+0}– 24^{+6} weeks, resuscitation should be started unless the parents and clinicians have considered that the baby will be born severely compromised. However, the response of the heart rate to lung inflation using a mask will be critical in deciding whether to proceed to intensive care. If the baby is assessed to be more immature than expected, deciding not to start resuscitation may be considered in the best interest of the baby. In the 1995 study, although 313/382 (78%) of babies born at this gestational age (313) were given intensive care, 198 (66%) died. Half of the survivors (52) have a moderate or severe disability at 6 years of age (table 1). Early findings in the EPICure 2 study (2006) show that, at this gestational age, survival has increased significantly by 12%. More babies were treated for retinopathy of prematurity, but there is no evidence of any change in other early major morbidity.

(D) 25 weeks and greater

When gestational age is 25^{+0} weeks or more, survival is now considerably greater than in 1995. It is appropriate to resuscitate babies at this gestation and, if the response is encouraging, to start intensive care. In the 1995 study, 389/424 (92%) babies born alive at 25 weeks were admitted for intensive care, but 171 (48%) died. Of the survivors, 27% had no identifiable impairment at 6 years of age. In 2006, survival had increased significantly from 54% to 67%, but there is no evidence of any change in early major morbidity.

(E) Uncertain gestational age

If gestational age is uncertain (ie, no dating ultrasound scan) but thought to be >23+0 weeks, an ultrasound scan by an experienced sonographer should be carried out if time permits. If the fetal heart is heard during labour, a professional experienced in resuscitation and another clinician (neonatal nurse or trainee paediatrician) should be called to attend the birth. A decision should then be made, in the best interests of the baby, as to whether resuscitation should begin with mask ventilation. Once begun, the response of the heart rate to lung inflation will be crucial in judging how long to continue resuscitation. If there is any uncertainty about management, guidance from more senior staff should be sought urgently.

INTENSIVE CARE

The response of the baby to mask ventilation is critical in deciding whether to start intensive care. If the heart rate increases rapidly and the colour improves, appropriate ventilatory support, including intubation and surfactant therapy, should be given, and the baby transferred to the neonatal unit for further assessment. There is no evidence to support the use of epinephrine by any route, or chest compressions, during resuscitation at gestational age <26 weeks. Management should be decided by doctors and nurses experienced in neonatal intensive care.

WITHHOLDING OR WITHDRAWING RESUSCITATION OR INTENSIVE CARE

When resuscitation or intensive care is withheld or withdrawn, the baby should be given all the care needed for his/her comfort and the parents encouraged by appropriate staff to hold and spend time with their baby, if they wish, in a quiet and private location. Further recommendations can be found in a RCPCH monograph on withholding or withdrawing life-sustaining treatment. When a baby dies, the parents should be offered bereavement counselling, including advice about post-mortem examination. At an appropriate time, the prognosis for future pregnancies should also be discussed

Resuscitation

Three aims of resuscitation: **DRY & KEEP WARM**
OXYGENATE
RETURN THE BABY TO MOTHER

Or – think of WOMB: Warmed, Oxygenated, Mothered, Breast-fed

HAVE AN ALGORITHM IN YOUR MIND AS TO HOW TO PROCEED FROM ONE STAGE TO THE NEXT DURING RESUSCITATION - SEE NEXT PAGE.

Remember the order of resuscitation:

A	**Airway**
B	**Breathing**
C	**Circulation**
D	**Drugs**

1. Familiarise yourself with the resuscitaires and the equipment.

2. New SHOs should expect to be taught on resuscitation within 48 hours of starting the job: if this does not happen: say so!

3. If you fear a baby is going to be in very poor condition - call for help **before** the birth.

4. Check the resuscitaire is working before the baby is born

STOPPING RESUSCITATION in ASPHYXIATED BABIES:

1. **No heart beat for 10 minutes** despite full resuscitation and appropriate drugs.

2. **No respiratory efforts at 30 minutes**. Be sure baby is not overventilated and hypocarbic.

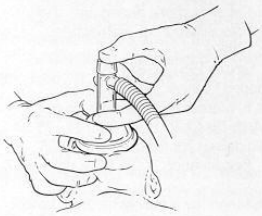
ALGORITHMS

The next page shows The Resuscitation Council's Neonatal Life Support algorithm, showing an "ABC" approach up to chest compressions

Newborn Life Support

At all stages ask: Do you need HELP?

Head in neutral position



Oxygen supply via mask
Use a well fitting face mask connected to pressure limited gas supply
Each breath 2-3 seconds duration at 30 cm H_20 for a term baby

Get help from a second person
to support the airway and/or inspect the oropharynx under direct vision and consider suction and/or insert an oropharyngeal airway

Chest compression
Compression rate: 120/min
Comp/vent ratio: 3:1

Dry the Baby
Remove any wet towels and cover
Start the clock or note the time

Assess colour, tone, breathing and heart rate

↓

if not breathing

Open the airway

↓

If still not breathing

Give 5 inflation breaths
Look for a response
If no increase in heart rate look for chest movement

↓

If no response

Recheck head position
Apply jaw thrust
Repeat inflation breaths
Look for a response
If no increase in heart rate look for chest movement

↓

If still no response

Try alternative airway opening manoeuvres
Repeat inflation breaths

Look for a response
If no increase in heart rate look for chest movement

↓

When chest is moving

Give ventilation breaths
Check the heart rate

If the heart rate is not detectable or slow (<60) and not increasing

Start chest compressions
3 compressions to each breath

↓

Reassess heart rate every 30 secs
Consider venous access and drugs

If meconium present and
- **baby breathing well:**
  Do not suction the airway
- **baby floppy and not breathing well:**
  Consider inspection and suction before inflation breaths

If breathing:
Reassess heart rate and monitor baby

If heart rate is satisfactory or increasing:
Continue ventilation breaths at about 30/min until baby is breathing adequately

If heart rate is satisfactory or increasing:
Continue ventilation breaths at about 30/min until baby is breathing adequately

If the chest is not moving:
Recheck head position and repeat inflation breaths
If competent, consider intubation

If the chest is still not moving:
The airway is the problem

If heart rate is increasing:
Stop compressions
Continue ventilation breaths at about 30/min until baby is breathing adequately

NLS

Special groups of babies

Preterm and low birth weight.
Keeping warm is an issue:
Ask for theatre/delivery room temperature to be increased

Work under overhead heater in draught free area
Wrap in a plastic bag without drying if < 30 weeks
Monitor the axillary or inter-scapular temperature with a probe plugged into the resuscitaires.
Do not use inter-scapular temperature if the baby is on an active Transwarmer mattress.
Change wet sheets for **warm** dry ones
Keep exposure to minimum
Give surfactant on labour ward if intubated and < 30 weeks
Move the baby on the resuscitaire or in the transport incubator.
Bring to NNU soon: Let parents hold first if possible

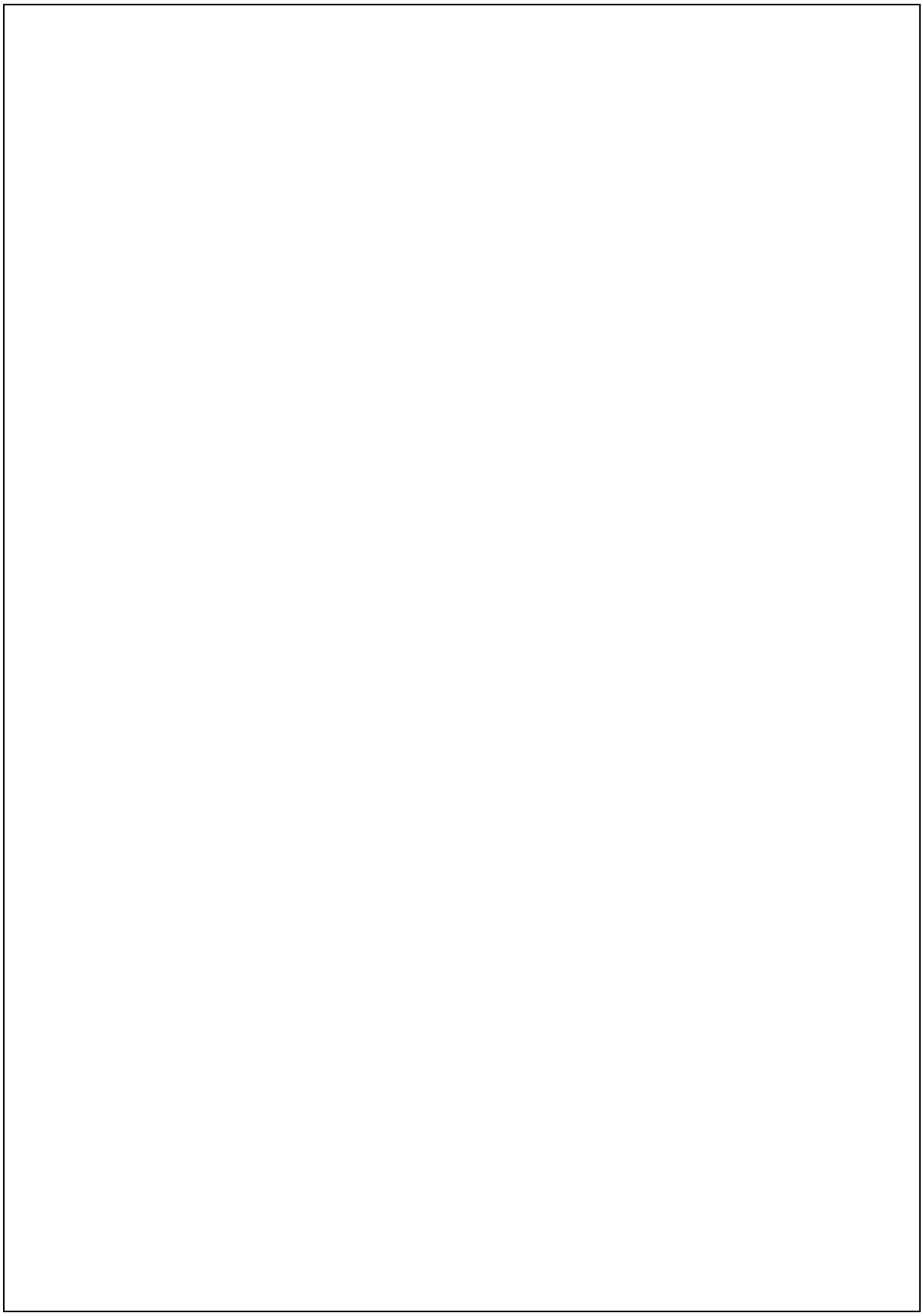
Caesarean section babies.
Fetal lungs secrete fluid. This is reversed in term babies by catecholamine surges during labour - then the lungs are compressed in the birth canal, and only small amounts of fluid are left in the lungs prior to the first breath. CS babies therefore have excess lung fluid at birth and may "drown". However, most will clear this fluid very rapidly, but watch for bradycardia and apnoea soon after birth. Most will respond to T-piece and mask ventilation with 5 good inflation breaths, but if intubation is needed, suck out through the ETT before ventilating.

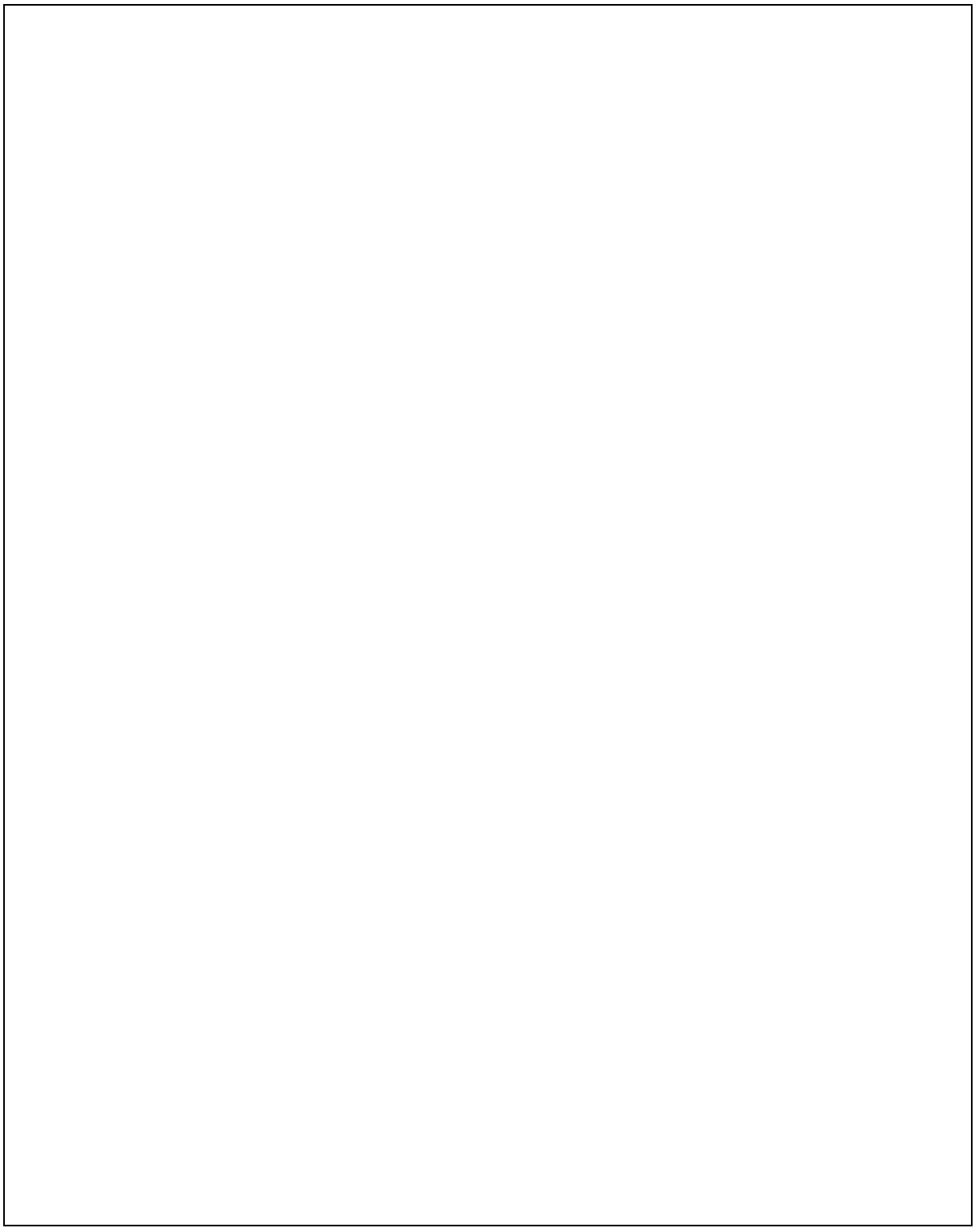
Meconium stained liquor
About 8-10% of babies are born through meconium stained liquor. Aspiration of this can lead onto meconium Aspiration Syndrome (MAS) with potentially fatal consequences. It can occur in utero. There is no benefit in aspiration of the oro-pharynx when the baby's head is delivered.

1. Chest compression before resuscitation and/or saline lavage during resuscitation are not beneficial.
2. The NLS course says:
   "Screaming babies have an open airway. Floppy babies – have a look"
3. This may be the best approach, though others debatably suggest that suction is not helpful

Hydrops fetalis
Usually diagnosed antenatally by ultrasound.
Consultant to attend delivery if hydrops severe.
Many causes of hydrops: severe anaemia is one. This may be caused by haemolysis, and if a problem is anticipated, **cross match a unit of O neg. blood with maternal serum** to be ready at birth in case a transfusion has to be started on the resuscitaire.
If this is not ready, and blood is needed, do not use unmatched O negative blood – see procedure for obtaining emergency blood.
2 doctors should be at the delivery: one to ventilate, one to gain vascular access by a UVC.
Take blood for investigation of the cause (minimum of FBC, Group, Coombs, + 5ml in plain tube, usually for virology) PRIOR to transfusion. If heart failure is severe, create a negative fluid balance (withdrawing more low-haematocrit neonatal blood than is transfused in).
Consider early drainage of pleural effusions + ascites if respirations are compromised.

Intubation





INADEQUATE RESPONSE TO INTUBATION+ VENTILATION ?

FIRST CALL FOR HELP: CALL FOR HELP: CALL FOR HELP

CRASH CALL THE REGISTRAR and NEONATAL SISTER by asking someone to Dial 2222 and say "Neonatal Emergency on Labour Ward"

A: Problems with the tube

1) Watch the chest: does it rise and fall well with breaths?
2) Tube in oesophagus (don't be fooled by loud breath sounds!)
2) Tube too small: resultant air leak around tube + failed lung expansion
3) Tube too far down: ? in right main bronchus
4) Tube blocked by meconium/blood etc
5) Check on pressure gauge that you are delivering 20 or 30cm H_2O pressure

B: Problems with the baby

1) Severe asphyxia/prematurity: ? needs longer inspiratory times, ECM, drugs and more work
2) Severe aspiration: transfer ventilated to NNU
3) Pulmonary hypoplasia: check facies, history of oligohydramnios?
4) Diaphragmatic hernia: check sounds both sides, cardiac apex
5) "Very stiff lungs": persist with 30 cm pressures, try more inflation breaths, ventilate on NNU
6) Pneumothorax especially if you've used high pressures
7) Congenital heart disease/other abnormalities
8) Unexpected severe anaemia/acute blood loss
9) Sepsis

Some like to remember the acronym DOPE as a quick first check:

D	**D**isplaced tube
O	**O**esophageal tube
P	**P**neumothorax
E	**E**quipment failure

- **A very sick baby will need continuous ventilation:**
- **Transfer in intensive care incubator or on resuscitaire**
- **Move to NNU quickly but without panic**
- **Keep the baby warm**

DRUGS

Drugs should be used only after adequate airway, ventilation and chest compressions fail to improve the baby's condition. They are not a substitute for these techniques. On labour ward, only 4 drugs are needed: adrenaline, bicarbonate, glucose and naloxone.
Check what the nurses give you: from time to time a baby receives syntometrine because of poor checking.

- The only indication for naloxone is depression from maternal analgesics.
- Adrenaline is preferably given via a UVC or alternatively via the ETT (1st dose 10 x bigger). There is no evidence base for its use at < 26 weeks
- Bicarbonate should not be used routinely, only for severely asphyxiated babies, to whom it should be given as a **slow** infusion, not as a bolus.
- Don't ever forget glucose (DEFG!) - but try to check a Medisense reading first

DRUG DOSES FOR RESUSCITATION

DRUG	DOSE	ROUTE	COMMENTS
Adrenaline 1 in 10,000	IV - 1st dose 0.1ml/kg then 0.3* to 1.0ml/kg/kg (*NLS dose) ET 1.0ml/kg	IV ENDOTRACHEAL	Repeat dose or give via UVC if inserted **ET adrenaline to be used ONLY if UVC cannot be inserted**
Sodium Bicarbonate	2 mmol/kg (2ml/kg of 8.4% or 4ml/kg of 4.2%)	IV	**Slowly** over 5 to 10 mins: dilute 1:1 with 5% or 10% dextrose to give 4ml/kg of 4.2% sodium bicarbonate.
Dextrose	250 microgram/kg (2.5ml/kg of 10% dextrose or 1.25 ml/kg of 20%)	IV	Asphyxiated babies can be hypo: repeat dose if BM still low after first bolus
Naloxone	200 microgram if >2.5kg 100 microgram if <2.5kg Intubate if <1.5kg	IM	IM only Adult vial has 400 micrograms in it

Calcium and Atropine have not been shown to be effective in neonatal resuscitation.

MW revised February 2010.

Delayed Cord Clamping

(The text below is an edited version of the SWMNN draft guideline (2010))

Introduction
A delay of 30 seconds, or more, in umbilical cord clamping leads to significant benefits for the newborn infant.

Benefits for term babies include a better iron status during the first few months of life.
The benefits for preterm infants are a lower incidence of hypotension, a reduced need for blood transfusions and fewer having intraventricular haemorrhages.

Delayed cord cutting does not interfere with active management of the 3rd stage of labour and does not case significant delays should resuscitation be needed. It is associated with an increased risk of jaundice requiring phototherapy.

Term Infants (equal to or more than 37 weeks gestation)

Parents need to be told that the cord will not be clamped immediately (unless the health professional leading neonatal resuscitation deems it appropriate). When the infant is born she is assessed and triaged into one of two categories:

2.1 Baby appears well

►The infant is dried and placed on the maternal abdomen or on or between the mothers legs, and kept warm. The baby can be put to the breast straight away if wished, the mother can be lying down, semi-recumbent or sitting upright at this time. The cord is not clamped and cut for at least two minutes. There is no evidence of benefit for delaying cord clamping beyond two minutes.

2.2. Appears to be in need of resuscitation

►The professional leading resuscitation makes a rapid assessment of the infant and if she appears in need of resuscitation she is handed to a midwife or doctor holding a towel (sterile drape at C/S) who lowers the infant as far as possible below the level of the placenta as the cord will allow. This may be no lower than the bed/operating table that the mother is lying on.
►She should be stimulated by gentle rubbing/drying with the towel if she is not breathing, it is best if the baby takes her first breath and expands her lungs (drawing blood from the placenta) before the cord is cut.
►The 30 second period of placental transfusion starts when the buttocks are delivered for a cephalic presentation or the head for a breech presentation
►The thirty second interval should be counted out by paediatric staff, " ten seconds, twenty seconds" etc
►The cord is clamped and cut after 30 seconds.
►The first minute after birth is mainly occupied by assessment and stimulation of the infant and hence she will not be compromised by a slightly delayed transfer to the resuscitaire
►This may leave a lot of cord attached to the baby. This can be trimmed later.

If at any time the professional leading resuscitation considers that it is in the best interests of the infant to cut the cord before the above times have elapsed then the cord must be clamped and cut immediately.

Preterm Infants (less than 37 weeks gestation)

The infant should be held at least 10 -15 inches (25 to 40 cm) below the level of the placenta for 30 seconds. The cord is then clamped, cut and the baby moved to the resuscitaire.

►All staff and parents should be aware that a 30 second period of placental transfusion, following delivery, is being planned.
►The infant should be held in a towel or plastic wrap/bag (sterile drape at C/S) and kept warm.
►A midwife who is allocated to assist with resuscitation or a paediatrician will usually hold the baby. The baby will be held at the side of the bed / operating table 25 to 40cm below the level of the placenta for 30 seconds. If the cord is not of sufficient length the baby will be held as low as possible for 30 seconds.
►The 30 second period starts when the buttocks are delivered for a cephalic presentation or the head for a breech presentation
►She should be stimulated by gentle rubbing/drying with the towel if she is not breathing, it is best if the baby takes her first breath and expands her lungs (drawing blood from the placenta) before the cord is cut.
►The thirty second interval should be counted out by paediatric staff, " ten seconds, twenty seconds" etc.
►This thirty second period should be viewed as *part of* the infants resuscitation not a hindrance to it.

If at any time the professional leading resuscitation considers that it is in the best interests of the infant to cut the cord before the above times have elapsed then the cord must be clamped and cut immediately.

Alternative approach – cord stripping

There is less evidence to support this practice but it is still superior to immediate clamping. Delayed cord clamping as described above is to be preferred in most situations but there will be occasions on which the paediatric and obstetric staff do not feel able to wait the full 30 seconds, for example if the baby is very pale, appears lifeless and does not respond to tactile stimulation. The cord can be quickly stripped and then cut.
The infant is held 10 -15 inches (25 to 40 cm) below the level of the introitus or incision. A 20cm section of the cord is milked (stripped) by the midwife/obstetrician using a gloved hand in the direction of the baby. The milking speed should be approximately 10cm per second. The cord should be milked 2 or 3 times and then clamped and cut.

Summary

Term and well – two minutes on maternal abdomen or legs and then cut cord
Preterm or unwell – thirty seconds below placenta and then cut cord

All cases – Document time of cord clamping

Note on cord blood gas analysis

For medico legal purposes it is important to document the time at which the cord was clamped as delayed clamping reduces pH and increases base deficit values in umbilical artery blood samples. The changes at thirty to sixty seconds after birth are small – see below.

Summary of Evidence

Cochrane review of delayed cord clamping in term infants
"A more liberal approach to delayed cord clamping in healthy term infants appears to be warranted, particularly in light of growing evidence that delayed cord clamping may be of benefit in the longer term in promoting better iron stores in infants"
Studies showed an increased risk of jaundice requiring phototherapy (indications for phototherapy not given) of 2%. With immediate clamping 3 % of term babies required phototherapy – a level probably above that in most maternity units.
Infants had higher ferritin levels at 3 & 6 months of age in the delayed clamping group.

Cochrane review of early versus delayed umbilical cord clamping in preterm infants
"Delayed cord clamping by 30 to 120 seconds rather than early clamping seems to be associated with less need for transfusion and less intraventricular haemorrhage."

Umbilical cord clamping after birth – better not to rush. BMJ editorial 2007; 335:312-3
"So long as the cord is unclamped the average transfusion to the newborn is 19ml/kg birth weight, equivalent to 21% of the neonate's final blood volume."

Acid base equilibrium in umbilical cord blood and time of cord clamping.
Obstet & Gynae 1984; 63(1) p 44 - 47

Umbilical cord milking reduces the need for red cell transfusions and improves neonatal adaptation in infants born at less than 29 weeks gestation: a randomised controlled trial.
Arch Dis Chld Fetal Neonatal Ed 2008; 93:F14 -19
The milked group was more likely not to have needed red cell transfusion and had a decreased number of RBC transfusions (milked group 1.7 vs controls 4.0). Mean blood pressure at admission was significantly higher in the milked group (34 vs 28mmHg). There was a significant decrease in major IVH in the milked group and a significant decrease in the incidence of CLD at 36 weeks.

Delayed cord clamping in very preterm infants reduces the incidence of intraventricular haemorrhage and late onset sepsis: a randomised, controlled trial
Pediatrics 2006; 117(4) p 1235 – 1242
Delayed cord clamping (< 32 weeks by 30- 45 seconds, baby held 10- 15 inches below placenta) showed a significant benefit on rates of IVH and late onset sepsis.

Umbilical cord clamping and preterm infants : a randomised trial. BMJ 1993; 306:172-5
Babies 27 -33 weeks were held 20cm below placenta for 30 seconds. Significant reduction in RBC transfusions and duration of supplemental oxygen.

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RESPIRATORY PROBLEMS

Mechanical Ventilation

This document provides guidance when ventilating babies. It provides guidance on physiology of ventilation, when ventilation may be necessary, specific conditions, modes of ventilation (e.g. SIMV, HFOV etc.), monitoring and documentation, blood gas limits. It is written primarily for use at Heartlands level 3 unit but can also be used for the initial management of a ventilated baby at Good Hope.

The primary indication for mechanical ventilation is respiratory failure. In newborns this may be central in origin (e.g. hypoxic ischemic encephalopathy, apnoea of prematurity) but is usually the result of fatigue and an inability to expand stiff lungs. More immature babies are more likely to require help, because they have surfactant deficiency, less muscle power and energy reserves.

If you find yourself dealing with a new or unfamiliar respiratory problem, blood gas results etc make your own decision first, then check it out with your next most senior colleague. This is good for patient safety and important for your own learning.

Mechanical ventilation is broadly of two types-
1. Conventional or tidal ventilation and
2. High Frequency or non tidal ventilation.

In conventional ventilation, breath rates similar to physiological respiratory rate are used and the tidal volumes delivered are also in the physiological range. These tidal volumes are larger than the anatomical dead space and gas flow occurs by bulk or convective flow. On the other hand high frequency ventilation (HFV) is a form of mechanical ventilation that uses very small tidal volumes which are equal to or even smaller than even the anatomical dead space and very rapid ventilator rates greater than 150 breaths per minute. Gas exchange occurs by other mechanisms apart from bulk or convective flow.

Classification of Conventional ventilation

Pressure controlled ventilation is where the ventilator measures and controls the airway pressure making it rise to the set maximum. Tidal volume delivered varies with breaths depending on the compliance (or degree of stiffness) of the lungs. As lung pathology

improves and compliance improves the pressures have to be weaned. This is traditionally the way babies have been ventilated.

Volume controlled ventilation on the other hand is where the ventilator measures and controls the tidal volume to the set value irrespective of lung compliance. The pressure generated to deliver the set volume will thus vary with higher pressures generated if lung compliance is low (stiff lungs). As compliance improves pressures needed to deliver the set tidal volume automatically decreases (auto weaning of pressure).

As both pressure limited and volume controlled modes have certain advantages, combined or hybrid modes of ventilation that have the features of both volume controlled and pressure limited modes have been developed. These modes have certain common characteristics

- They are primarily pressure limited modes
- The delivered tidal volume is monitored by the ventilator and if desired tidal volume is not being achieved changes are made automatically to the settings and delivered breath to optimise tidal volume delivery. For example if the desired tidal volume is not delivered the ventilator will automatically increase the pressure delivered till this is achieved. Examples are Volume mode on Stephanie and Volume Guarantee on the Drager.

The Volume mode on the Stephanie provides volume targeted ventilation. If compliance improves the ventilation pressure required to deliver set tidal volume adjusts to the lowest possible value. If the compliance decreases the pressure required to achieve the set tidal volume increases automatically. Sometimes this can exceed the set upper limit of peak pressure. In this case supplied tidal volume will be less than set tidal volume. Consideration to changing the upper limit will then need to be given or an alternative method of ventilation will be needed.
Within both Volume ventilation and Pressure limited ventilation it is possible to use Assist Contol and SIMV.

Assist control (AC) ventilation

Assist Control ventilation allows the baby to determine his/her own rate and timing whilst maintaining a safety net of mandatory (or CONTROL) ventilation if he fails to trigger a

breath within the time interval specified by the set rate. This mode provides the maximum support to babies and should be used initially in most babies.
Synchronisation is the best way of tuning the ventilator to the baby and avoiding 'fighting'. Randomised control trials (RCTs) have not shown clear long term benefit although synchronisation may be associated with a shorter duration of ventilation.
An assisted breath is delivered each time a signal is sensed unless this is during a short refractory period. The signal is triggered by flow sensing in the Stephanie. The sensitivity needs to be set low enough for the machine to sense the very low flows generated by small babies. Generally keep this at the minimum setting. Sometimes setting the sensitivity too low in bigger babies may cause excessive triggering from small non-respiratory movements. Examine the flow / time waveform looking for the infant's own effort, presence of artefact or interference, and re-set trigger level as appropriate.

If spontaneous effort is sensed during the time interval determined by the set rate a mandatory assisted breath is delivered. The set rate is the minimum assistance the baby can receive. The rate displayed shows the summed (triggered+mandatory) breaths/min. When you have set it up, stay by the bed-side and look at what is happening. Is the system triggering too fast or too slow? A very fast rate is suggestive of 'auto-cycling'.

On the **Stephanie** each baby triggered ventilator assisted breath is marked under the waveform by an "A". Breaths delivered but not triggered by the baby are marked "C". If you do not see many "A" symbols then the strategy is not working properly (see below).

Example: Backup rate 60/min. If the baby's spontaneous rate is 90/min s/he will receive 90 assisted breaths but if no breath is sensed for 1 second a control breath will be delivered. The Stephanie's display will show 90 bpm above, but the backup rate below. If the baby becomes apnoeic 60 breaths/min will be given.

Synchronised intermittent mandatory ventilation (SIMV)

In this mode assisted breaths are only delivered if the baby fails to breathe within the breath to breath time interval determined by the set backup rate. It is thought of as a 'training mode' for the respiratory muscles during weaning. The set rate is the maximum assistance the baby can receive but backup rates <20/min may cause atelectasis in

small babies and have been associated with higher risk of extubation failure. Can be used in both VCV and TCPL.

Example: Backup rate 30/min. If the baby's spontaneous rate is 90/min he/she will receive 30 assisted breaths synchronised with respiratory effort and 60 breaths will cause no machine activity. If no breath is sensed in a 2 second 'window' a mandatory breath will be delivered. The display will show 30 bpm.

Deciding when to ventilate

The primary indication for mechanical ventilation is presence of or impending respiratory failure.

Ventilation problem

Respiratory failure occurs when the arterial PCO_2 is above 8 kPa, but not every baby with a PCO_2 >8 kPa requires ventilation. View the PCO_2 as a **trend** and consider in the context of the likely underlying pathology and the baby's overall condition. Early use of CPAP reduces the subsequent need for ventilation and we are using CPAP on labour ward for preterm babies 26- 30 weeks gestation (see guideline on resuscitation of preterm babies).

- A progressive rise in PCO_2 in a baby on CPAP who is a few hours old and has HMD will probably get worse before getting better. Early ventilation needs considering.
- A baby with chronic lung disease (CLD) may run an arterial PCO_2 of >8kPa and it would be inappropriate to interfere if the pH is compensated.

Oxygenation problem

Consider both the arterial PO_2 and the oxygen requirement. It is the **trend** that is important.

- Preterm babies with HMD on CPAP may benefit from early intervention + surfactant if the oxygen requirements are increasing (consider ventilation if FiO2 > 50%)
  - Babies born at term or near term with hypoxic respiratory failure due to persistent pulmonary hypertension will need ventilation.

Clinical

The two most important clinical features to look for are the degree of recession and, the spontaneous respiratory rate/regularity. The more the recession and the

faster the respiratory rate the worse the lung disease. Early intervention with nasal CPAP will maximise FRC and minimise work of breathing. Beyond a certain point the muscles become so fatigued that recession may become less and the rate may fall or there may be apnoea. By this time there is likely to be extensive atelectasis. In addition, it is frequently possible to tell by continued observation (usually by the nurses) that a baby is getting tired. Clinical observation of this sort should prompt earlier intervention with ventilatory support (CPAP or mechanical ventilation) than reliance on blood gases alone. **Apnoea in a baby with significant lung disease is a serious sign.**

MECHANICAL VENTILATION – physiology

Tidal Volume (Vt)

Tidal Volume delivered was inferred traditionally from the degree of visible chest movement but this can be quite subjective. With availability of modern machines this is measured for us. As uncuffed tubes are used there is always a leak of gas around the tube. Both inspired and expired Vt is measured. We target expired Vt in the range of 4-6 mls/kg in preterm babies and 4-8 mls/kg in bigger babies.

Minute Ventilation

Tidal volume x respiratory rate. Normal values 200 to 480 mls/kg/min.

Carbon Dioxide removal (also called ventilation in physiological terms)

During spontaneous respiration and conventional mechanical ventilation there is a linear relationship between Minute ventilation and the arterial PCO_2.

During Pressure limited mechanical ventilation Vt is proportional to delta P which is the difference between PIP and PEEP. To increase CO2 removal in this mode either increase delta P by raising PIP or increase the rate.

During HFOV CO2 removal is proportional to the amplitude of the oscillations (also called delta P or Posz) and less on frequency of the breaths. Paradoxically reducing frequency increases CO2 removal in this mode this is because the attenuation of the pressure waveform as it travels down the ET tube increases with increasing oscillator frequency, and so higher frequencies will result in less ventilation for a Posz.

We use HFOV with a frequency setting of 10 Hz and increase CO_2 removal by increasing the Posz. If CO_2 removal cannot be achieved with increasing oscillation, a lower frequency (7-8 Hz) may help.

Oxygenation

Increasing the mean airway pressure (MAP) and/ or increasing the FiO_2 improves oxygenation.

MAP approximates the area under the inspiratory curve which is determined largely by the peak pressure (PIP), the end expiratory pressure (PEEP), the inspiratory time (T_i) and, to a lesser extent, the time taken to reach the inspiratory plateau.

During HFOV, oxygenation will be optimal when the MAP (equivalent to PEEP) is only just high enough to recruit all alveoli. The pressure required to inflate the lung to this volume depends on lung compliance. Over inflation of lungs can compromise oxygenation by reducing cardiac output.

Compliance

Measure of degree of stiffness of the lungs.

Defined as change in Volume per unit change in Pressure. The more stiff the lungs are the lower their compliance and more the pressure needed to achieve required tidal volumes.

Blood gases

Blood gas measurements should be made in any sick baby. The frequency will depend on the condition of the baby. If direct arterial access is unavailable capillary blood from a well perfused heel yields values for pH and PCO2 which correlate well with arterial samples. Remember that the aim of respiratory support is tissue oxygenation and this also depends on [Hb] and cardiac output.

Target blood gases for preterm babies

pH: 7.25-7.35

pCO_2: 4.5-6.5 Kpa

pO_2: 7-10 Kpa or oxygen saturation 85-95%

There may be situations where higher PCO2 levels are acceptable e.g. PIE or BPD. Low PCO2 levels impair cerebral blood flow and are potentially far more injurious than high levels so avoid levels <4.5kPa.

In **term babies**, and especially those with PPHN we tend to aim for (refer to PPHN guidelines)

- **PO_2 (post ductal) >8kPa**

- **PCO_2 4.5-6kPa**

- **pH 7.3-7.4**

If you are unsure what the target ranges and/or acceptable levels are in an individual case take senior advice.

Whenever you interpret a blood gas result and make a change to the ventilation, write the new settings into the appropriate boxes on the blood gas chart. If the blood gases are seriously abnormal, a note in the clinical record of your interpretation, management plan and plan for re-assessment is best practice.

Guide ventilation protocol for preterm babies with RDS using conventional ventilation

	Volume Controlled	Time Cycled Pressure Limited
Tidal volume	Initial mode Assist Control. Adjust volume dial on the ventilator to deliver 4-6 ml/kg expired tidal volume as measured at proximal ETT. Adjust PIP dial to set maximum pressure that can be delivered 5 cm water above what is needed to deliver the set tidal volume. This is **a safety net to ensure excessive pressures/volumes are not delivered inadvertently** as the Stephanie is capable of delivering tidal volumes up to 250ml. Ensure expiratory tidal volume is no less than 70% of inspiratory tidal volume (i.e. leak not > 30%).	Initial mode Assist Control. Adjust Peak Inspiratory Pressure (PIP) on the ventilator to deliver 4-6 ml/kg expired tidal volume as measured at proximal ETT.
Inspiratory time and set rate	Use inspiratory time dial on ventilator to adjust inspiratory time to between 0.25-0.35 sec and set back up rate of 60 bpm	Use inspiratory time dial on ventilator to adjust inspiratory time to between 0.25-0.35 sec and back up rate of 60 bpm
Target ABG	pH: 7.25-7.4 pCO_2: 4.5-6.5 Kpa pO_2: 7-10 Kpa or oxygen saturation 85-95%	pH: 7.25-7.35 pCO_2: 4.5-6.5 Kpa pO_2: 7-10 Kpa or oxygen saturation 85-95%
Subsequent adjustments	Wean by reducing rate in Assist Control if babies spontaneous breaths < 60 or switch to SIMV and then wean on rate. **You do not need to adjust the set tidal volume.**	Wean by reducing Peak Inspiratory Pressure (PIP) set as tolerated but ensure that the tidal volume is no less than 4mls/kg.Continue in Assist Control mode with control rate of 60.
Weaning to extubation	Switch to SIMV when clinically stable on control rate of 40. Load and start Caffeine citrate in preterm babies Ensure target expiratory tidal volumes of at least 4 mls/kg. If stable on this start decreasing SIMV backup rate. Decrease SIMV rate to minimum of 20.	Switch to SIMV when clinically stable on control rate of 40 and PIP less than 18. Load and start Caffeine citrate in preterm babies Decrease SIMV rate to minimum of 20 or decrease PIP to wean
Trial of extubation	If tolerating the minimal settings and Mean Airway Pressure is less than 8.0 cm water for 12 hours extubate to nasal CPAP.	If tolerating the minimal settings andMean Airway Pressure is less than 8.0 cm water for 12 hours extubate to nasal CPAP.

High Frequency Oscillatory Ventilation (HFOV)

The principle of HFOV is to expand the lungs to the point where all alveoli are just recruited and hold them at that volume. To achieve this it is usually necessary to apply a distending pressure (PEEP) which is high enough to overcome the stiffness of the lungs. Because the mean lung volume (MLV) achieved is somewhere around two thirds of the volume reached with a quiet tidal breath it is not possible to ventilate conventionally on top of this volume. HFOV gets around this by using rapid (6-15 Hz) oscillatory pressure changes which achieve ventilation with volume changes which are near to or less than dead space volume.
The advantages of HFOV are that oxygenation can often be achieved much more efficiently than with conventional ventilation and that there is less likelihood of damage by the repetitive forced opening of small airways which have been allowed to close in expiration (so called 'atelecto-trauma'). Many RCTs failed to find advantages to a strategy of elective use of HFOV, and a large recent UK trial came to similar conclusions.

HFOV in Practice

We currently use HFOV primarily as a rescue therapy (ie when conventional ventilation is failing), but tend to use it earlier in those babies with PPHN. Its use should be considered in any baby whose oxygenation index (OI) reaches 15 or more. It may be useful in babies who have air leaks. **Start with a MAP 2cm higher than used for conventional ventilation and set rate to 10Hz.** To achieve the appropriate degree of oscillation look at the chest. It is best to start off with a low oscillation (start with the knob turned fully anticlockwise) and slowly increase to achieve visible but not excessive chest vibrations - this is likely to be around a Posz of 30-35 in term babies. In a small babies you may not need to turn the knob very far. If you are unfamiliar with HFOV ask for senior advice before starting. Check a blood gas after 30 minutes – over-ventilation can be a problem.

- If oxygenation improves reduce FiO_2 as tolerated

- If SaO_2 does not improve you may have over-distended the lungs. Try and ↓ MAP by 2cm H_2O (or more) - the SaO_2 should improve within a minute or two if this was the case.

- If the above does not work, ↑MAP by 1-2cm and consider CXR to assess lung expansion. The lungs should be well expanded but with <10 ribs showing.

PCO_2control

- Increase oscillations to blow off more CO_2 and vice versa to raise PCO_2. Generally these steps should be no more than 2-3 dP

- If PCO_2 still too high on maximum settings and good wobble check the chest expansion and movement. Consider possibility of hyper-inflation and try to ↓ MAP to see if 'wobble' increases.
- If no benefit get a CXR to exclude hyperinflation.

  - Reducing the frequency to 7-8 Hz may be useful. Discuss with senior colleague.

Maintenance and weaning

When the FiO_2 is down to <40%, ↓ MAP in 1 cm decrements. Then either progressively reduce MAP to 6-7cm H_2O and extubate to nasal CPAP or switch to conventional ventilation when MAP is around 10-12cm. There are no clear guidelines for this and you will need to consider how sick the baby was, the underlying pathology and response to HFOV, and any co-existent problems e.g. air leaks.

Table: Approximate OI at varying MAP and PaO2 at 100% and 80% oxygen

MAP			100% FiO2			80% FiO2
PaO2	6kPa	8kPa	10kPa	6kPa	8kPa	10kPa
12cm	27	20	16	21	16	13
14cm	31	23	19	25	19	15
16cm	35	27	21	28	25	17
18cm	40	30	24	32	24	19
20cm	45	33	27	36	27	21

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Sedation/ analgesia during mechanical ventilation

Routine use of sedation and analgesia using opiates for infants being ventilated is not recommended. There may be a role for analgesia in term infants with PPHN (see guidelines on PPHN), or in babies who have developed NEC or had surgery. **Never** paralyse an infant being ventilated without discussing with consultant. Any infant who is distressed or uncomfortable during adequate trigger ventilation may be given a bolus of diamorphine at a dose of 30 microgram/Kg over 30 minutes followed by an infusion at 15 to 30 micrograms/Kg/hr. Most infants on trigger ventilation appear comfortable and relaxed and routine use of morphine or sedatives should not be required. There is some evidence from clinical trials (Anand et al) that routine analgesia may have detrimental effects.

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Anand KJS, Hall W, Desai N, et al. Effects of morphine analgesia in ventilated preterm neonates: primary outcomes from the **NEOPAIN** randomised trial. *Lancet.* 2004;363 :1673 –1682

Surfactant Guidelines

GENERAL COMMENTS

- Surfactants work best if given early in the disease.
- We use Curosurf which is derived from porcine lungs. Dosage used is 100-200 mg/kg phospholipid for prophylaxis and 200 mg/kg for rescue treatment.

- All babies 23-25 weeks gestation who are intubated on Labour Ward should be given a small (120mg) vial of CUROSURF there.
- Babies < 30 weeks who are intubated for resuscitation on labour ward should also be given CUROSURF.
- Babies initially managed on CPAP who fail this therapy should be given surfactant as soon as possible after intubation (rescue therapy). A dose of 200 mg/kg phosholipid may be used in these babies.
- For babies > 1200g, term babies, or babies transferred in, give the first dose of Curosurf as soon as possible after intubation for ventilation.

- Do not wait for an x-ray unless there is **real** doubt about the diagnosis.

INDICATIONS OF SURFACTANT

- Very preterm babies on Labour Ward (as above)
- The infant is intubated and ventilated for RDS
- Ventilation for meconium aspiration
- Consider use in PPHN and pulmonary haemorrhage

ADMINISTRATION of Curosurf

- Ready to use: no reconstitution. Do not filter or shake
- Warm to room temperature and draw into syringe. Cut a feeding tube so that its length is just less than that of the cut ET tube
- A doctor or trained neonatal nurse MUST remain with the patient during administration.
- Administer as a bolus direct into the ET tube at a dose of 100-200 mg/kg as above. Administer rapidly and as quickly as the baby tolerates. Baby should be supine and flat throughout.
- Transient bradycardia or desaturation may occur needing hand ventilation or increase in pressure of ventilator.
- Ventilation requirements may decrease significantly after administration- when ventilation may need reducing quite rapidly.
- Avoid suctioning for at least 4 hours unless absolutely indicated for a blocked tube.

SECOND DOSES :

Do not use if the baby is extubated, or the baby is ventilated in <30% oxygen and the ventilatory requirements are falling. For other babies a second dose should be used after 12 hours or earlier after discussing with the consultant.

THIRD AND LATER DOSES

There is no convincing evidence for beneficial effect of more than two doses in babies with RDS.
This is usually a consultant decision

IF IN DOUBT: ASK!

References;

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Persistent Pulmonary Hypertension of Newborn (PPHN)

This document has been written as guidance in the management of babies with PPHN admitted to the neonatal unit at HEFT. PPHN is a condition characterised by marked pulmonary hypertension resulting from increased pulmonary vascular resistance (PVR) and altered pulmonary vaso-reactivity, leading to supra-systemic pulmonary vascular pressures and consequently extra-pulmonary right to left shunting of blood across Patent Foramen Ovale and Patent Ductus Arteriosus. It occurs in a variety of clinical situations which can also cause intra-pulmonary shunting of blood. These include Meconium Aspiration Syndrome, hypoplastic lungs (e.g. in congenital diaphragmatic hernia), congenital pneumonia, sepsis, hyaline membrane disease and rarely in conditions like primary lymphangectasia. Some cases for which no cause is found remain idiopathic.

Infants with PPHN are exceptionally unstable and difficult to manage. Their management should always be discussed with the consultant on call.

Pathogenesis

1. Mal-adaptation of the pulmonary vascular bed to the transition at birth exacerbated by perinatal stress such as hypoxia, acidosis, and hypoglycaemia.

2. Under development of the lungs along with pulmonary vasculature (e.g. congenital diaphragmatic hernia, Congenital Cystic Adenomatoid Malformation) is frequently associated with PPHN.

3. Anatomic abnormality of the lungs and pulmonary vascular bed (e.g. pulmonary hypoplasia with pulmonary arteriolar smooth muscle hypertrophy) following chronic intrauterine hypoxia may also play a role.

4. Birth asphyxia with hypoxia, acidosis and shock is clinically associated with increased reactivity of the pulmonary vascular bed.

Clinical features

1. The primary finding is respiratory distress with cyanosis confirmed by demonstration of hypoxemia. This may occur despite adequate ventilation

(normal pCO_2). Other clinical findings are variable and depend on severity and associated disorders.

2. In addition to respiratory distress PPHN should be suspected when there is marked lability in oxygenation with routine nursing care and minor stress.

3. Cardiac signs: Auscultation may be normal or reveal single, loud second heart sound with murmur of tricuspid or pulmonary regurgitation.

Diagnosis

1. This is essentially one of exclusion of significant cyanotic congenital heart disease and severe parenchymal lung disease. However, PPHN may coexist with significant parenchymal lung disease.

2. Have a high index of suspicion for the 'at risk' group in a term baby with respiratory distress and cyanosis, particularly if there has been a history of intrauterine hypoxia and meconium exposure or birth asphyxia.

3. Differential oximeter readings: In the presence of right to left shunt at ductal level the pre ductal saturations (right hand) are higher than post ductal saturation (left hand and feet). A difference of >5% is indicative of PPHN. However it is important to realise that PPHN cannot be excluded if this difference is not seen as shunting can occur predominantly at level of PFO.

4. Chest X ray may show normal sized heart or cardiomegaly. If there is no pulmonary disease there may be diminished or normal pulmonary vascularity. If there is parenchymal lung disease then the degree of hypoxemia may be out of proportion to the severity of pulmonary disease.

5. Echocardiogram.
   This is crucial to exclude cyanotic congenital heart disease (particularly transposition of the great arteries, and totally anomalous pulmonary venous return). In the presence of significant parenchymal lung disease, cardiac assessment is less urgent.
   Echocardiography is also useful to

   a. Assess myocardial function, which is often severely affected

   b. Assess the severity of PPHN, and assess responses to treatment.

      1. Tricuspid regurgitation - allows indirect measurement of the pulmonary pressure and therefore severity of PPHN

      2. Ductual shunting

      3. Shunting through the foramen ovale

Management

The key principals are

1. Reverse right to left shunting Lower pulmonary vascular resistance. Maintain systemic blood pressure to keep it above pulmonary arterial pressure.

2. Improve arteriolar oxygen saturation and oxygen delivery to the tissues.

3. Minimise trauma to the lungs.

1. Oxygen and ventilation	1. 100% O_2 Always start with 100% oxygen and reduce the FiO_2. In the short term there is little risk to a term baby using such measures. 2. Maintain PaO_2 7-12 kpa 3. $PaCO_2$ in the normal range 4.5-6 kpa if this can be achieved 4. Elective use of HFOV to increase lung recruitment, particularly in combination with inhaled Nitric Oxide, has been shown to reduce the need for ECMO and to be superior to conventional ventilation with iNO. Discuss with consultant on call. Remember that till the lungs are adequately inflated nitric oxide is less likely to work. 5. Do not hyperventilate. Target pH is 7.35-7.45.
2. Blood pressure	1. Arterial access is crucial in management for blood gases and monitoring blood pressure. 2. Myocardial function is frequently poor, despite reasonable blood pressures. 3. Aim to keep the mean arterial pressures above 50mm Hg in term infants 4. Use dopamine -starting with10 mcg/kg/min and increasing up to 20 mcg/kg/min and/or dobutamine 5-20 mcg/kg/min. If systemic pressure rises and pulmonary pressure stays the same, R-L shunt will diminish and oxygenation will improve. 5. Nor adrenaline/Adrenaline infusions may be indicated if there is severe myocardial dysfunction. Discuss with consultant.
3. Sedation	1. Many babies are very unstable with swings in saturations on handling/ minor procedures. 2. Consider early use of diamorphine infusion.
4. Muscle Relaxation	1. This may be necessary to gain initial control in very vigorous babies who are not adequately sedated with narcotics. 2. Use paralytic agents like vecuronium PRN if necessary preferably for 24 hours or less.
5. Pulmonary vasodilators	1. Inhaled nitric oxide (iNO) is the vasodilator of choice in term and near term infants with hypoxemic respiratory failure. It has been shown to reduce the need for ECMO in term and near term babies with PPHN. iNO should be started at 20ppm and reduced to 5ppm , according to response and to stability. Discuss with consultant on call. Reduce iNO more slowly after 5ppm in steps of 1ppm in order to reduce the chances of rebound pulmonary hypertension. Met haemoglobin levels should be monitored (these are measured automatically on blood gases) Normal levels < 2%. Nitrogen dioxide (NO_2) levels should be monitored and kept below 1ppm.

	2. With the availability of iNO intravenous vasodilators such as tolazoline and prostacyclin are no longer used because of the risk of side effects especially systemic hypotension.
6. Hyperventilation	Inducing alkalosis by hyperventilation should be avoided as it increases the risk of barotrauma.
7. ECMO	1. This is essentially prolonged cardio-pulmonary bypass and is life saving treatment provided the cause of respiratory failure is reversible. At present it is only available for babies > 2kg, > 34 weeks gestation provided there are no contraindications (see SWMNN ECMO guidelines). 2. Criteria in UK ECMO trial was infants who had an Oxygenation Index (OI) >40. With use of iNO it is appropriate to discuss infants who may potentially require ECMO with the PICU specialist early rather than when ECMO or death is imminent. Consider discussions when OI is > 25-30. This is a consultant decision. $OI = \frac{MAP \times 100}{PaO_2 \text{ (mmHg)}} \times FiO_2$ where MAP is Mean Airway Pressure, PaO2 is the arterial oxygen tension in mmHg (1kPa = 7.5mmHg), and FiO2 is the fraction of inspired oxygen (100% = 1.0, air = 0.21)

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Nitric Oxide Therapy

The physiologic rationale for the clinical use of iNO in hypoxemic respiratory failure secondary to PPHN (persistent pulmonary hypertension) is based on its ability to achieve sustained and potent pulmonary vasodilatation without causing systemic hypotension. Persistent pulmonary hypertension of the newborn is a disorder associated with diverse underlying pathologies which is characterised by high pulmonary vascular resistance causing extra pulmonary right to left shunting of blood across the patent ductus or foramen ovale or both. This causes severe hypoxemia not responsive to oxygen therapy. iNO by lowering the pulmonary arterial pressure abolishes or decreases this shunt producing the immediate improvement in oxygenation seen in infants with PPHN.

Oxygenation can also improve in some infants without extra pulmonary shunting. These infants have predominantly intrapulmonary shunting due to ventilation perfusion mismatch as a result of atelectasis. In these infants NO is thought to improve oxygenation by redirecting blood from poorly aerated or diseased lung regions to better aerated spaces. This has been called the 'micro selective effect'.

In addition clinically unproven effects of NO that have been demonstrated in models of lung injury such as reduction in inflammation and oedema and protective effects on surfactant function may also play a role.

Clinical trials of Inhaled Nitric Oxide Therapy in term newborns.

The first trials reporting the use of NO in the treatment of term newborns were published in 1992. Roberts and Kinsella in separate studies demonstrated an improvement in oxygenation of babies with hypoxemic respiratory failure with the use of iNO.

The Neonatal Inhaled Nitric Oxide Study Group (NINOS) and the Clinical Inhaled Nitric Oxide Research Group (CINRGI) are the pivotal multicenter randomised trials that have demonstrated that iNO therapy improved oxygenation and reduced the need for ECMO treatment in term and near term (≥ 34 weeks gestation) infants with hypoxemic respiratory failure and persistent foetal circulation by 15-24%. These trials have also shown that there is no difference in mortality between infants given iNO and controls due to the availability of ECMO as a rescue therapy. Following these trials NO became licensed for the treatment of severe hypoxemic respiratory failure in term and near term infants.

Finer has reviewed the role of nitric oxide for respiratory failure in infants born at or near term for the Cochrane database. 12 eligible randomised controlled trials were included in the

analysis. NO therapy was shown to reduce the incidence of combined outcome of death or need for ECMO. The reduction was purely in the need for ECMO, mortality was not reduced. This finding is primarily due to the efficacy of rescue ECMO for these infants.

Hypoxemic respiratory failure in term newborns however is a heterogeneous group of disorders and disease specific response rates have been seen. The NINOS trial showed that patients with extra pulmonary shunting (PPHN) and Pneumonia show the best response and survival without the use of ECMO and those with intrapulmonary shunting (as in RDS) have less response to NO treatment. iNO may be less effective in the presence of pulmonary parenchymal disease. Atelectasis and air space disease will decrease the delivery of NO to its site of action. In patchy parenchymal disease iNO may be effective due to the 'micro selective effect'. In diffuse parenchymal disease and atelectasis however pulmonary hypertension is due to the adverse effects of atelectasis on pulmonary resistance and effective treatment of the underlying disease is essential to cause resolution of the pulmonary hypertension. Thus while using NO it is essential that ventilator management be optimised to obtain optimal ventilation and lung inflation.

The early trials on iNO used initial doses that ranged from 80ppm (parts per million) to 6-20 ppm. These doses were based on data from animal models. Since then evidence from randomised controlled trials in the use of iNO suggests that it should be used with an initial dose of 20ppm. The NINOS trial used an initial dose of 20ppm. If PaO2 did no increase by > 20 mm Hg then the dose was increased to 80ppm. Only 6% of infants who did not respond at 20ppm responded with increase in PaO2 of > 20 mm Hg at the higher dose. Whether this increase would have occurred if the dose remained at 20 ppm could not be determined by the trial.

We currently do not use doses above 20 ppm due to lack of evidence for its efficacy and increased risk of side effects.

Monitoring

Careful monitoring of NO and nitrogen dioxide levels is needed during therapy. The nitrogen dioxide levels should be maintained as low as possible and always less than 0.5 ppm. Methaemogloin levels are also monitored and kept below 2.5%. High nitrogen dioxide

concentrations and elevated methaemoglobin levels are generally not seen when doses of 20 ppm or less are used.

Weaning and discontinuation

After improvement in oxygenation weaning the dose of iNO becomes important. Several approaches have been used with little differences in oxygenation until the final discontinuation of NO which is a distinct process from weaning. Discontinuation of NO can cause a rebound increase in pulmonary hypertension which can be associated with decreased oxygenation. This rebound is generally transient and most patients respond to increased inspired oxygen concentrations. Restarting iNO therapy is needed in some patients. iNO withdrawal can however be associated with life threatening elevations of hypoxemia secondary to elevation of pulmonary pressure. Davidson in a randomised trial comparing NO withdrawal at 1, 5 and 16 ppm showed that the decrease in oxygenation on withdrawal of NO was related to the dose of NO prior to discontinuation and was the least at 1ppm.
The usual duration of NO therapy in the pivotal trials has been less than 5 days which parallels the resolution of PPHN.

iNO in preterm infants

The role of iNO in preterm infants with hypoxemic respiratory failure is controversial in terms of its safety and efficacy with the iNNOVO trial showing no benefit of using iNO in preterm babies with severe respiratory failure.
Of late there has been interest in using low doses of iNo prophylactically in preterm infants to reduce BPD. The most recent Cochrane review of preterm infants includes 11 studies and 3,370 participants. The results show a statistically significant reduction in the combined outcome of death or chronic lung disease (CLD) in two studies with routine use of iNO in intubated preterm infants. However, uncertainty remains as a larger study showed no significant benefit for iNO for this combined outcome. Also, trials that included very ill infants do not demonstrate significant benefit. One trial of iNO treatment at a later postnatal age reported a decrease in the incidence of CLD. These are still in experimental stage and the decision to use iNO in babies less than 34 weeks gestation is a consultant decision.

References

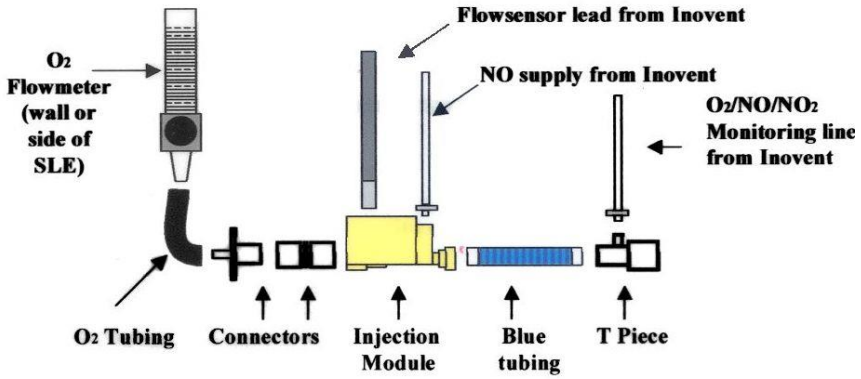
Kinsella JP Clinical trials of inhaled nitiric oxide therapy in the new born Pediatrics in Review. 1999;20:110-113. doi:10.1542/pir.20-11-e110

Kinsella JP Inhaled nitiric oxide therapy in premature newborns. Curr Opin in pediatrics 2006, 18: 107-11

Setting up NO Therapy- (this is done by nursing staff)

a. Collect the accessories needed as outline in the pre-use procedure
b. Run through the Inovent pre-use procedure:
   i. Do a system high pressure leak test:
      - Turn both cylinders on and off
      - Watch pressure dials for 30 seconds to see if the pressure drops
      - If it does fall, change to backup Inovent
   ii. Do a low range calibration
      - Go to calibration, confirm to calibrate NO, NO_2 and O_2
      - If test fails – retry, if fails again, use back up Inovent

   iii. Set up a test circuit for Purge and Performance test as below:

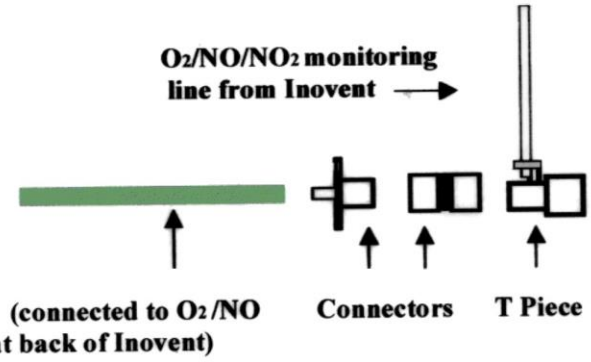


      - Purge the system
      - Turn oxygen cylinder to 15 litres and set the NO delivery to 40 ppm
      - Check both cylinder gauges go to zero (if this doesn't happen, check the cylinders are turned off and try again.)
      - Check for 2 alarms 1) Low NO/NO_2 pressure 2) Delivery failure
      - If test fails, swap to back up Inovent

   iii. Check performance
      - Turn on the cylinder you intend to use for therapy
      - Set the O_2 to 15 litres and the NO to 20 ppm
      - Wait for 3 minutes,
      - Check O_2 = 95% +/- 3%
      - Check NO 16 – 24 ppm
      - Check NO_2 < 1ppm
      - If readings are not within acceptable limits, do a high calibration or use back up machine.

   iv. Check performance of manual back-up system
      - Remove Injection Module and blue tubing from test circuit as below
      - Remove green O_2 tubing from O_2 flow meter and connect to O_2/NO outlet on the back of the Inovent

Inovent.



- Turn backup system flow meter on side of Inovent to 15 litres
- Check flow indicator ball has risen inside Perspex screen on front of Inovent
  - Check O_2 = 97% +/- 3%
  - Check NO 5 – 15 ppm
  - Check NO_2 < 0.5ppm
- If reading of between 5-15 ppm not achieved, then use back up Inovent

v. Connect to the ventilator

- When pre-use checks are complete, turn off bagging system flow meter and change set NO level to zero. Inovent can then be connected to the ventilator circuit. Once all connections are made, NO set level can be set to the prescribed dose of NO. This may need to be adjusted slightly to achieve the desired dose on the read-out.
- If Inovent is not connected to the ventilator within 10 minutes, NO_2 may start to build up in the tubing.

Detail of the connection of the Injection module to a Stephanie ventilator is shown below:

Pneumothorax

Aetiology

1. Spontaneous- seen in up to 1 % of normal births; only approximately 10% are symptomatic.
2. Lung disease such as respiratory distress syndrome, meconium aspiration and pulmonary hypoplasia. Mechanical ventilation is associated with increased incidence of pneumothorax.

Presentation

Most pneumothoraces occur within 48 hours of birth, and are very rare after 7 days. About 50% of pneumothoraces happen while a baby is on CPAP. Consider this before ventilating a baby deteriorating on CPAP. They are particularly likely to occur if a ventilated baby is fighting the ventilator and the PIP is above 20 mbar.

Consider the possibility of a pneumothorax in a ventilated baby if there is:

- Abrupt collapse
- an increase in oxygen requirement, and/or a rising pCO2 – think DOPE – D for displaced ETT; O for obstructed ETT, P for pneumothorax and E for Equipment error.
- hypotension/poor perfusion

Diagnosis

• Look at the chest. Is one side over-expanded or moving less? Is there decreased air entry to one side?

• Transilluminate the chest- switch lights off and use incubator cover – this is very useful in small babies, less so in the larger baby. Beware false positives in babies with severe pulmonary interstitial emphysema..

• If there is free air the heart should be visibly pulsatile or the lung or diaphragm can be seen to move. Oedema and pleural fluid give a more solid appearance without the pulsatile heart or diaphragm .

• Move the light to several points anteriorly and laterally on each hemithorax

• XRay remains the gold standard for diagnosis but should be done after the pneumothorax is treated or if there is real doubt about the diagnosis.

Treatment

Not all pneumothoraces need drainage. If the baby is relatively asymptomatic and the pneumothorax not under tension careful observation and follow up X ray may be all that is needed. A tension pneumothorax is a medical emergency and will need treatment

Emergency treatment – Needle aspiration

Where time/clinical condition does not allow formal definitive drainage, needle aspiration is used as a first procedure:

- Cut off the connecting hub of a 21G butterly and insert the cut end under water in a small bottle of sterile water/saline. Insert the needle into a high intercostal space (second or third) anteriorly in the mid clavicular line until air bubbles are seen.
- Always use the intercostal space just above the rib to avoid intercostal vessels in the inferior surface of the ribs.
- Once air bubbles are seen stop advancing the needle to avoid risk of puncturing the lung.

• **Keep the cold light on** so that you can see the effect on the pneumothorax.

• Leave the butterfly in and proceed to drainage.

If the baby is reasonably stable and you have time proceed directly to a chest drain

Insertion of chest drain

- Choose drain of appropriate size- For small babies size 10 Fr and size 12 for larger infants.
- Locate the 5th intercostal space in the mid axillary line on the affected side. (4th and 6th space can also be used). NB This is well away from the nipple.
- Create a clean field and cover with sterile drapes
- infiltrate with lignocaine 1%, consider a morphine bolus.
- Make an incision about 1 cm long directly above the sixth rib using a sterile blade
- Then either cut right through to the pleural space or blunt dissect through using artery forceps. Applying continuous firm pressure enter the pleural space using a closed artery forcpes. It is probably safer to remove the trochar completely – if you do use it do not let the trochar more than just enter the pleural space (no more than 1 to 1.5 cm) then advance the drain over the trochar angling it so the drain tip lies anterior to the lung.

- Insert the drain a few centimetres. Be sure the side ports of the tube are within the pleural space. On the Argyle chest drains the last hole is 2cm from the tip, and the last line is 6cm from the tip.

- Connect the drain to the underwater seal and start continuous suction (~5kPa).

- Manipulate drain using **cold light** until air is drained satisfactorily.

- Fix the drain with steristrips **and** with sticky film. Avoid purse string sutures especially in very preterm babies as they leave scars.

- Get a CXR to verify drain position and lung expansion. If residual air remains the drain may need to be adjusted or a second drain inserted.

- Transilluminate again if improvement less than expected.

Insertion of additional drains

- If, despite manipulation of the drain and the application of suction, the baby does not improve clinically, the pneumothorax may not have drained completely. This can be confirmed either by transillumination or X-ray depending on how urgent and critical the baby's condition is. A common reason for this failure is that the tip of the cannula is at the back of the chest, while the air in the pneumothorax is anterior with the baby on its back. Consider either:
    1. removal and reinsertion of the drain
    2. inserting a second drain throught the 2nd intercostal space in the mid clavicular line. Discuss with a consultant.

Removal of a drain

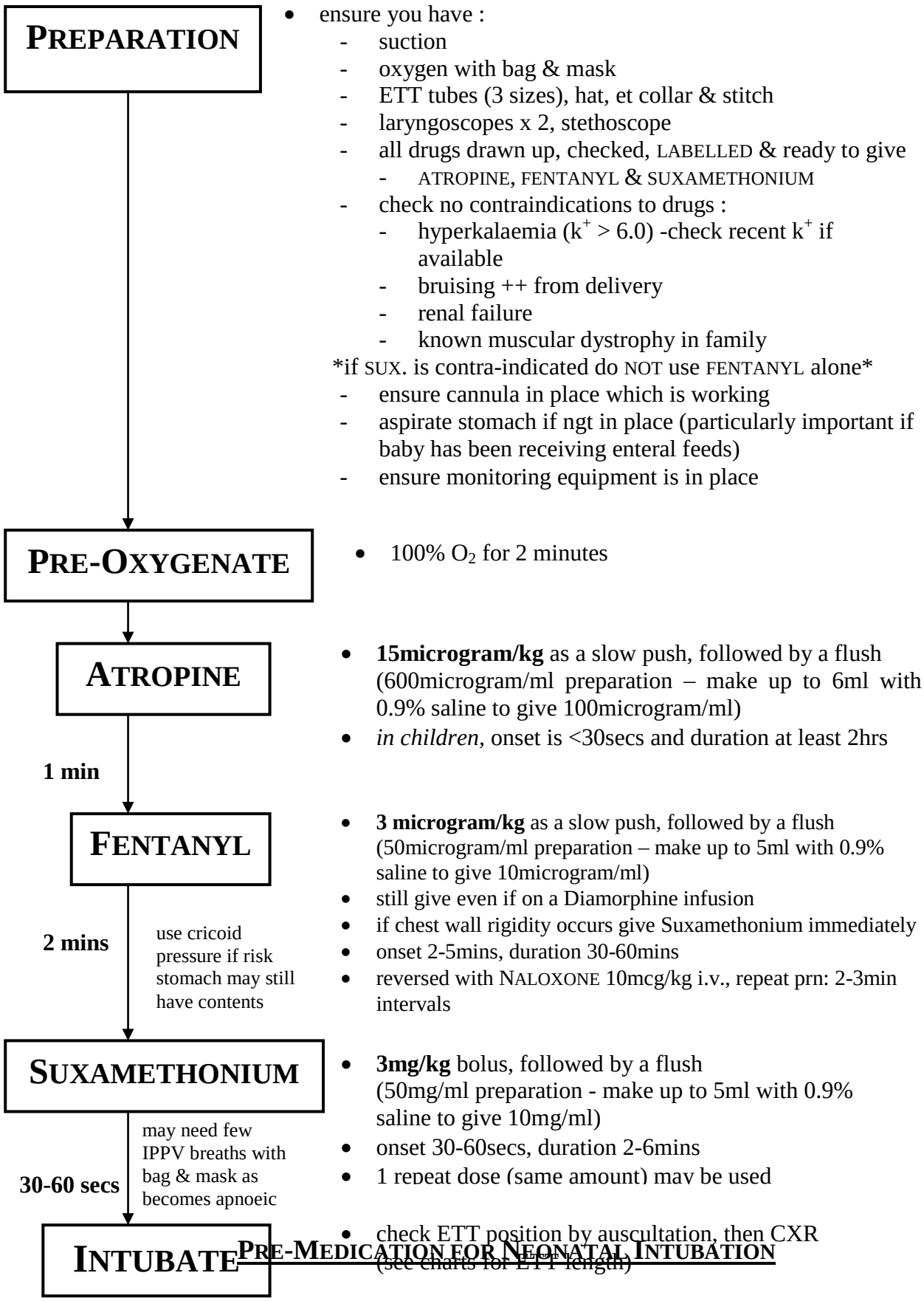
After 24 hours or so, when the baby is stable and the pneumothorax has resolved on the CXR, consider clamping the drain for 12 to 24 hours. If the baby deteriorates after clamping, transilluminate / re-Xray. If the pneumothorax has recurred, remove the clamp, check for bubbling and review the baby.

If the clamping of the drain is successful, withdraw the drain and close the wound preferably with steristrips unless it is very large and open, in which case a stitch may be needed.

References:

1. Gomella TL (Editor): Neonatology clinical manual. Lange Medical Books.
2. Donn SM, Sinha SK (Editors). Manual of Neonatal Respiratory Care.
3. Circulated to all neonatal consultants at Heartlands and Good Hope.
4. Watkinson M, Tiron I. Events before the diagnosis of a pneumothorax in ventilated neonates. Arch. Dis. Child. Fetal Neonatal Ed. 2001 **85**: F201-F203

Premedication for neonatal intubation



PRE-MEDICATION FOR NEONATAL INTUBATION

INDICATIONS FOR USE

- elective/semi-elective intubations
- i.e. *NOT* for emergency/arrest situation
  If the airway can be maintained & adequate oxygenation achieved with Neopuff or bag & mask ventilation then consider use of pre-medication
- *ALL* gestations & *ALL* ages

CONTRA-INDICATIONS TO USE

- intubation on labour ward
- if known airway problems - e.g. Pierre-Robin sequence
- if there is a contra-indication to the drugs used :
  - hyperkalaemia (check recent K^+ if available)
  - bruising ++ from delivery
  - renal failure
  - known muscular dystrophy in family
- ***if SUXAMETHONIUM is contra-indicated do *NOT* use FENTANYL alone***
  (risk of chest wall rigidity)
- the procedure should **not** be performed *alone* by someone with no/little intubation experience (it may be used with supervision by someone with good intubation experience)

PROTOCOL FOR INTUBATION FAILURE

- get help - senior, other Registrar
- maintain cricoid pressure if risk of aspiration
- continue bag & mask ventilation with 100% O_2
- give NALOXONE (NARCAN) to reverse FENTANYL (SUXAMETHONIUM will wear off quickly)

Protocol for Pre-Medication in Neonatal Intubation

The reasons for use of pre-medication are :

1. **TO PROVIDE ANALGESIA** (intubation is a painful procedure)
2. **TO BLUNT THE NORMAL PHYSIOLOGICAL RESPONSES TO INTUBATION** (thereby ↓ bradycardia, hypoxia & acute fluctuations in BP & ICP – these last 2 are risk factors for IVH in prems)
3. **TO PROVIDE IMPROVED INTUBATION CONDITIONS** (thereby enabling an easier, faster procedure & reducing the risk of trauma)

FENTANYL - Side-Effects

1. **Respiratory Drive Suppression**: ventilator rate may need to be ↑ until both Fentanyl & the paralysis has worn off

2. **Bradycardia** (of vagal origin): this will be prevented by ATROPINE

3. **Chest Wall Rigidity** (rare & more likely at higher doses & if given quickly)
   ALWAYS have a paralysing agent drawn up ready at hand before use
   - Normally, wait 2mins after giving Fentanyl before giving Suxamethonium – continue to oxygenate by applying bag & mask to face as infant becomes flaccid (if apnoeic give some IPPV breaths)
   - If chest wall rigidity occurs causing difficulty in bagging & maintaining saturations, give the Suxamethomium immediately.
   - **DO NOT USE FENTANYL ALONE** because of this risk of chest wall rigidity – i.e. if Suxamethonium is contra-indicated then so is Fentanyl.

SUXAMETHONIUM - Side Effects

1. **Bradycardia** (of vagal origin)
   more pronounced in neonates and with a 2nd dose, prevented with Atropine
   a repeat dose of Suxamethonium does not need to be preceded by a repeat dose of Atropine since the latter has a long duration of action of ~ 2hrs

2. **↑K^+** Suxamethonium briefly raises K^+ by 0.2-0.5mmol/l
   if a recent K^+ is available check this before use **(DO NOT give if K^+ > 6.0)**
   the rise in K^+ can be more pronounced in with renal failure & trauma –
   - **SUXAMETHONIUM is therefore contraindicated in infants with renal failure or who remain very bruised following a traumatic delivery**
   - **SUXAMETHONIUM is contra-indicated in infants where a family member is known to have a muscular dystrophy** - there have been occasional reports of cardiac arrest due to hyperkalaemia (thought due to an un-diagnosed muscular dystrophy)

3. **Malignant Hyperthermia (MH)**
   rare autosomal dominant disorder of skeletal muscle, incidence ~ 1/200,000 in UK
   manifests with ↑HR, ↑RR, hypermetabolism, muscle rigidity, hypercarbia, acidosis & fever
   known to be precipitated by volatile (inhaled) anaesthetic agents and Suxamethonium

Management of Malignant Hyperthermia

- check arterial gas, serum K^+ & CK (repeat CK after 6, 12 & 24hrs)
- monitor ECG for arrhythmias & signs of hyperkalaemia
- collect first voided urine for myoglobin
- hyperventilate with O_2
- give **DANTROLENE 1mg/kg i.v.**- available from Main & Orthopaedic theatres (Aug '02)
- repeat as required at 5-10 min intervals to maximum of 10mg/kg
- this will reverse the signs of MH (if not reconsider the diagnosis)
- treat any ↑K^+ or acidosis & give circulatory support if necessary
- active cooling & urinary alkalinisation to prevent tubular injury from myoglobinuria may also be beneficial

Cricoid Pressure

- cricoid pressure is applied for 2 reasons :
  1. To reduce the risk of aspiration of stomach contents –main reason

2. To allow better view of cords

- in neonates most re-intubations will occur in infants who are not enterally fed – in this situation application of cricoid pressure is less crucial
- in those who have been enterally fed, cricoid pressure is vital to ↓ the risk of aspiration (even if the stomach has been aspirated via an NG tube, some contents may remain)
- cricoid pressure needs to be applied by the assistant immediately after sedative administration & not released until correct placement of the ETT is confirmed or the drugs given have been reversed/worn off if intubation is unsuccessful

JM, 2002, revised VF 2004, JS 2010

ETT length:

ETT length at lips (cm)	Gestation (Wks)	Weight (kg)
5.5	**23-24**	**0.5-0.6**
6	**25-26**	**0.7-0.8**
6.5	**27-29**	**0.9-1.0**
7	**30-32**	**1.1-1.4**
7.5	**33-34**	**1.5-1.8**
8	**35-37**	**1.9-2.4**
8.5	**38-40**	**2.5-3.1**
9	**41-43**	**3.2-4.2**

NB : The above is a guide only. Tube position must be confirmed clinically (equal air entry on both sides with good chest movement) and by Chest Xray to ensure that the tube lies above the carina, ideally midway between glottis and carina.

JS 2010

Pulmonary haemorrhage

Pulmonary haemorrhage represents one end of a continuum of disorders characterised by pulmonary oedema. In the initial stages rising capillary pressure leads to a rise in interstitial fluid resulting in fluid loss into the alveoli and finally capillary haemorrhage. A sudden onset and a high mortality are characteristic. This is now largely a disorder of preterm infants ventilated for severe RDS and often with a large PDA causing failure. As the haemorrhagic fluid is protein rich, it inactivates surfactant worsening gas exchange. The haemorrhagic fluid has a haematocrit of 10%.
Risk factors for pulmonary haemorrhage in surfactant-treated infants include birthweight < 700 g male sex, presence of a PDA, and prophylactic use of synthetic rather than natural surfactant and excessive volume replacement

Clinical Features

- Sudden deterioration with large amounts of pink/red frothy fluid or frank blood from the infant's oropharynx or endotracheal tube if already intubated. There may be bleeding from other sites.
- Pallor, hypotension, bradycardia, cyanosis, apnoea or gasping respirations, shock.
- Widespread crepitations with reduced air entry. In surfactant treated infants, blood stained secretions may be the only sign.
- The CXR shows a "white-out", or may be less striking resembling RDS and there may be cardiomegaly.
- Blood gases characteristically show hypoxia and hypercarbia with a combined respiratory and metabolic acidosis.

Management

Urgent resuscitation is required to prevent sudden death.

- Endotracheal intubation for mechanical ventilation and simultaneous volume expansion with blood is a pre-requisite. A 10mls/kg saline bolus can be used if needed urgently. Also correct any underlying disorder(s).
- Use a high PEEP (6-7 cm H_2O) and longer inspiratory time (0.4- 0.5 seconds). If the infant is on HFO and not managing to maintain adequate gas exchange switch to CMV with long inspiratory time but reduce Ti at the earliest opportunity (risk of severe PIE).
- Frequent suctioning (up to several times per hour) may be required initially to prevent the ET tube blocking. The suction catheter should be measured so as only to protrude ~0.5 cm past the ET tube tip to avoid provoking fresh bleeding during suctioning.
- Additional surfactant therapy when pulmonary haemorrhage has occurred after the first dose may be beneficial (administer slowly and see how well it is tolerated).
- Transfuse fresh frozen plasma (10-15 ml/kg) and/or cryoprecipitate as indicated, with additional vitamin K to improve coagulation.
- Maintain the blood pressure with infusions of inotropes or colloid or blood
- Correct acidosis with bicarbonate.

References

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Soll RF. Synthetic surfactant for respiratory distress syndrome in preterm infants. In: The Cochrane Database of Systematic Reviews, 3, 2004. 10.1002/14651858.CD001149

Soll RF. Prophylactic surfactant for preventing morbidity and mortality in preterm infants. In: The Cochrane Database of Systematic Reviews, 3, 2004.

Stevens TP, Blennow M, Soll RF. Early surfactant administration with brief ventilation vs. selective surfactant and continued mechanical ventilation for preterm infants with or at risk for respiratory distress syndrome. In: The Cochrane Database of Systematic Reviews, 3, 2004.

Van Houten J, Long W, Mullett M, Finer N, Derleth D, McMurray B, et al. Pulmonary haemorrhage in premature infants after treatment with synthetic surfactant: an autopsy evaluation. J Pediatrics 1992;120:S40-4

Yost CC, Soll RF. Early versus delayed surfactant treatment for neonatal respiratory distress syndrome. In: The Cochrane Database of Systematic Reviews, 3, 2004.

Ewer AK, Tyler W, Francis A, Drinkall D, Gardosi JO. Excessive volume expansion and neonatal death in preterm infants born at 27–28 weeks gestation Paediatric & Perinatal Epidemiol 2003:17;180 et seq

RHM 2000, referenced MW 2006, JS2010

Convulsions

Please refer to Cooling guidelines as well
Causes include:

Asphyxia	35 to 56 %
Infection: meningitis, encephalitis, congenital viral	3 to 17 %
Intracranial haemorrhage: subdural, extradural, subarachnoid, SEH	23 to 46 %
Cerebral artery infarction	6 %
Acute metabolic disturbance: low sugar, Ca, Mg, Na, High Na	0 to 40 %
Inborn error of metabolism	4 %
Malformation	0 to 16 %
Others include: drug withdrawal, hypertension, benign neonatal seizures and idiopathic: figures vary between local populations	

Immediate management of convulsions:

Nurse

- Recovery position ⇐ **A** for Airway
- Oxygen if cyanosed (check saturation) ⇐ **B** for Breathing
- Check Medisense (see treatment of hypoglycaemia - fitting baby)
- Call doctor

Doctor

- Blood for glucose, Na, Ca, Mg, culture and ?gases
- USS head
- LP if meningitis a possibility

- If not hypoglycaemic and still fitting at 5 minutes:
    1) give diazemuls/diazepam 0.25mg/kg as slow IV bolus
    2) watch for apnoea
    3) If baby not fitting load with phenobarbitone 20mg/kg IV

Recurrent convulsions: assess each step before proceeding to the next:

1. ? Sure of diagnosis: ? drugs of abuse, ? congenital infection, ? I.E.M. etc
   Investigate and treat underlying causes

2. Repeat phenobarbitone 10mg/Kg IV/IM up to maximum loading dose of 30mg/Kg
3. Consider Phenytoin 20mg/Kg IV Discuss with consultant. A further half loading dose of 10 mg/kg can be used if fits persist.
4. Midazolam (preferred for babies being cooled- see guideline) or clonazepam infusion for babies with fits not controlled by above measures. ALWAYS DISCUSS WITH CONSULTANT
5. Paraldehyde 200-400 mg/Kg rectally
6. Consider pyridoxine (see drug charts)

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Cranial Ultrasounds

HAEMORRHAGE
(indicate L/R)
Mutually exclusive entries:
0. Normal
1. Localised IVH / SEH
2. IVH with ventricular dilatation
3. Other

VENTRICULAR SIZE
Mutually exclusive entries:
0. Normal
1. Ventriculomegaly $\leq 97^{th}$ centile
2. Ventriculomegaly $> 97^{th}$ centile
3. Shunted ventriculomegaly
(RECORD MEASUREMENTS)

PARENCHYMAL LESIONS:
Mutually exclusive entries:
0. None
1. Transient intraparenchymal echodensity (IPE $\leq$ 14 days)
2. Persistent IPE (> 14 days)
3. Single large (porencephalic) cyst
4. Multiple cysts (cystic PVL)
5. Haemorrhagic parenchymal infarction
6. Developmental cysts
7. Other (enter comment)

Please record your ultrasound findings in a standardised way. The adjacent boxes are from the ultrasound report form that should be completed at each scan. The classification is compatible with network and regional coding. There is an additional area in the scan report form for comments. However comments such as 'mild dilatation' must always be accompanied by measurements, that can be compared against the Ventricular Index (see below)

When you have done a scan please ensure that the nurse knows the findings so she can enter them into the database.

INDICATIONS

- Preterm <32 weeks
- VLBW <1500g
- Congenital abnormalities
- Large/small OFC
- HIE
- Seizures
- Clotting disorders

TIMING AND FREQUENCY

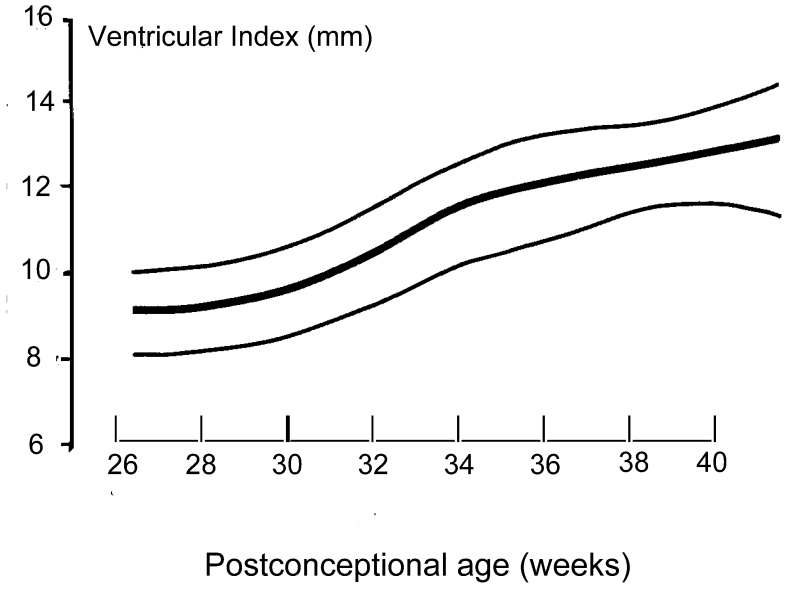
- Day 1
- Day 3
- End 1st week
- Weekly until discharge if abnormalities seen
- As condition of neonate dictates
- Final discharge scan for all

In preterm babies with early scan abnormalities the scan closest to term has the best 'correlation' with neurological outcome.

Please ensure that a consultant sees the scans before discussing the results with the parents

Measuring ventricular size

The graph below shows the 3rd and 97th centiles for the ventricular index (VI) defined as the distance from the falx to the lateral border of the lateral ventricle measured in the plane of the third ventricle . It has been used in many studies and trials. Treatment for post-haemorrhagic hydrocephalus is generally started if the VI is 4 mm above the 97th centile.



RENAL PROBLEMS AND MANAGEMENT

Antenatal renal ultrasound scans

Renal pelvis dilatation

Approximately 0.5-1% of babies will have abnormal antenatal renal USS. In the majority of babies the condition is benign. The challenge, within the population of babies scanned antenatally, is to identify the small number of babies who have significant renal disease. Babies with an abnormal antenatal scan will have a neonatal alert form.

Possible abnormalities: **(see flow chart on back page)**

1) Unilateral dilation of renal pelvis: (R**enal pelvis > 8 mm on scan at 34 weeks**)

Any baby with unilateral calyceal dilation on antenatal scans should:

- Go home on prophylactic trimethoprim, 2mg/kg od – this must continue until the baby is reviewed in outpatient clinic
- Have a renal ultrasound scan booked for 6 weeks post-term
- Have an outpatient appointment 2 weeks after the scan

The ST/ANNP discharging the baby must reinforce to the parents the importance of continuing with the prophylaxis until seen in clinic. They may need to obtain a further prescription from their GP. They must give appropriate advice to parents on the importance of urine testing if the baby is unwell and prompt treatment of infection if detected.

2) Bilateral dilatation of renal pelvis dilatation

In male infants posterior urethral valves should be suspected. Renal imaging must be performed before baby is discharged home (discuss with consultant – usually a MCUG will be necessary and prophylactic co-amoxiclav will be required for 3 days). In addition the baby should have a urinary stream documented.

If the MCUG does not reveal any obstruction, or if the infant is female the baby should:

- Go home on prophylactic trimethoprim, 2mg/kg od – this must continue until the baby is reviewed in outpatient clinic
- Have a renal ultrasound scan booked for 6 weeks post-term
- Have an outpatient appointment 2 weeks after the scan

The ST/ANNP discharging the baby must reinforce to the parents the importance of continuing with the prophylaxis until seen in clinic. They may need to obtain a further prescription from their GP. They must give appropriate advice to parents on the importance of urine testing if the baby is unwell and prompt treatment of infection if detected.

If posterior urethral valves are confirmed the urology registrar at BCH must be informed and a clear plan made for the ongoing management of the infant.

3) Infantile polycystic kidneys (rare):

- Scan baby's kidneys, liver pancreas pre-discharge
- Check FBC, urine/plasma electrolytes + creatinine
- BP
- Ensure consultant aware before discharge and follow-up plans clear

4) Multicystic kidney:
- Scan urinary tract before discharge
- Check FBC, urine/plasma electrolytes + creatinine
- BP
- Ensure consultant aware before discharge and follow-up plans clear

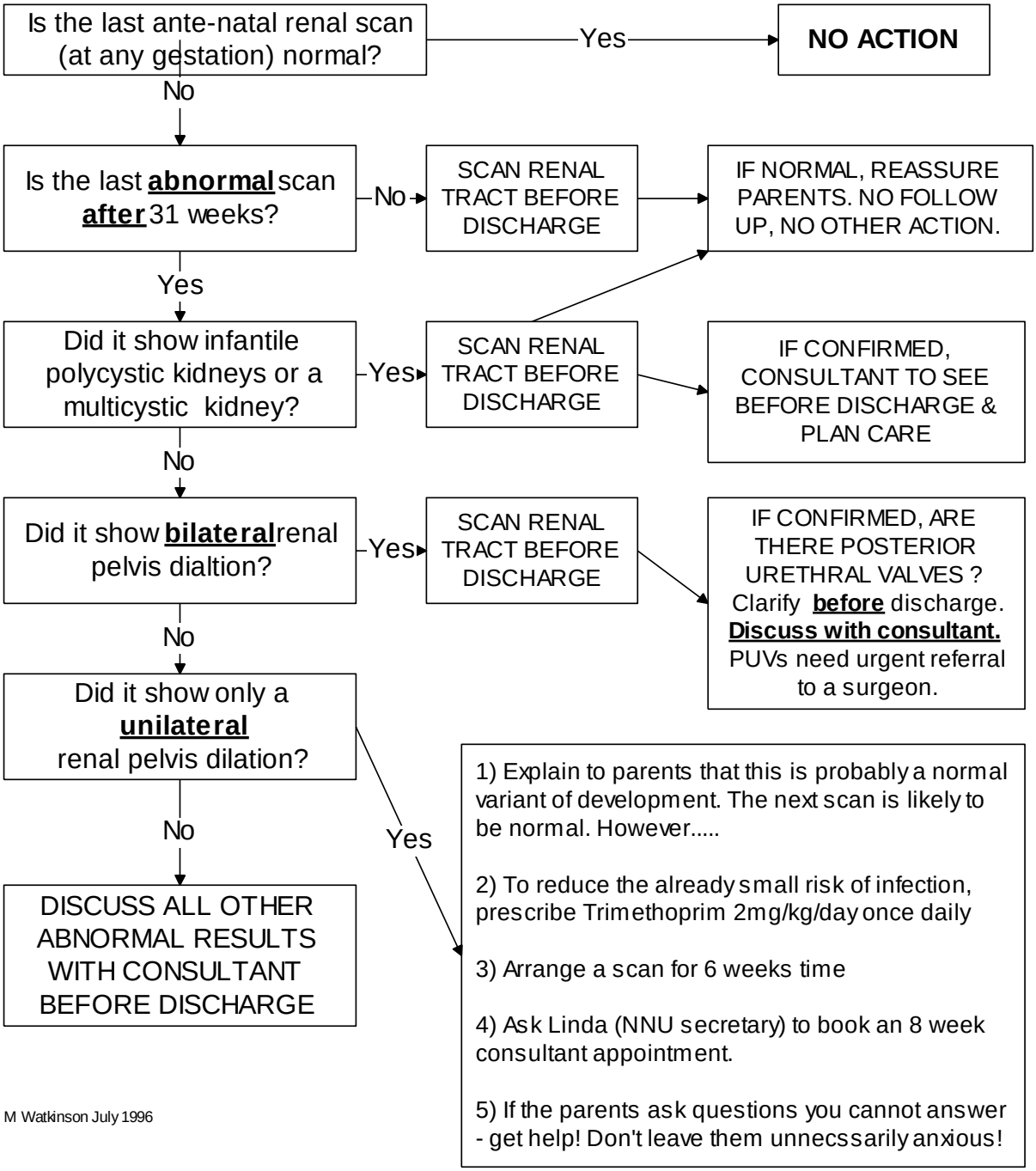
<u>At 6 to 8 week follow up:</u>

1) **Normal scan:** Reassure parents, stop trimethoprim, discharge

2) **Dilation with no calyceal involvement:** Maintain trimethoprim. Rescan in 6 months

3) **Dilation with calyceal involvement**: Maintain trimethoprim. Discuss need for further investigations with consultant

ANTENATAL RENAL SCANS



M Watkinson July 1996

AP 2010.

INFECTIOUS DISEASES AND VACCINATIONS

Group B Streptococcus(Streptococcus agalactiae)(GBS

The "best practice" guidelines are not intended to be prescriptive therefore the terms fever, pre-term and prolonged have not been defined and are left to the discretion of the individual centres.
The majority of early onset sepsis in the neonatal population in the UK is due to Group B streptococcus (0.63/1000).

WOMEN – GIVE INTRAPARTUM ANTIBIOTIC PROPHYLAXIS (IAP) SPECIFICALLY FOR GBS TO THE FOLLOWING WOMEN:

- **GBS known to be present in the vagina at any time during pregnancy.**
- GBS known to be present in the urine at any time during pregnancy.
- GBS infection in a previous baby.

GIVE BROAD SPECTRUM ANTIBIOTICS WHEN CLINICALLY INDICATED AND ENSURE THE REGIME INCLUDES ADEQUATE GBS COVER IN THE FOLLOWING SITUATIONS:

- Chorioamnionitis diagnosed or suspected clinically
- Pre-term prolonged rupture of the membranes

CONSIDER GIVING INTRAPARTUM ANTIBIOTIC PROPHYLAXIS (IAP) IN THE FOLLOWING SITUATIONS:

- Labour is preterm (<37 weeks)
- Prolonged rupture of the membranes in labour (>18 hours)
- Fever in labour (>38.3 degrees)

BABIES – GIVE ANTIBIOTICS TO THE FOLLOWING BABIES:

- Any baby who presents at any gestation with symptoms of sepsis, e.g. tachypnoea, mottling, grunting etc.
- Babies from multiple births where one baby is diagnosed with GBS disease even when well

CONSIDER GIVING ANTIBIOTICS TO THE FOLLOWING BABIES:

- Babies born to mothers who should have received IAP but did not.
- Babies born to mothers who received the first dose of antibiotics less than 2 hours prior to delivery
- Preterm babies whose mothers received IAP

TREATMENT REGIMENS

WOMEN with **any** indication for antibiotics should be offered intravenous antibiotics during labour for at least 2 hours before delivery. Some women prefer not to receive antibiotics if their risk is only slightly increased since it would complicate an otherwise normal birth. Also antibiotic therapy may be associated with rare but significant complications. **The risks of GBS in the baby must be balanced against the wishes of the mother and the risk of adverse reactions to antibiotics**.

- All women in whom it is recommended to GIVE antibiotics should be offered antibiotics immediately prior to the onset of labour.
- It is important to administer the first dose of antibiotics as soon as possible because intravenous antibiotics should be given at least 2 hours prior to delivery.

Recommendations for specific IAP for GBS

- Recommended doses of Penicillin G are 3g (or 5 mU) intravenously initially then 1.5g (or 2.5 mU) at 4 hourly intervals until delivery
- For women allergic to penicillin, the recommended dose of clindamycin is 900mg intravenously every 8 hours until delivery.

BABIES born to mothers in whom it is recommended to **GIVE** antibiotics and the mother has been given at least one dose at least 2 hours before should be assessed carefully by a paediatrician.

- If the indication for antibiotic administration is only the risk of GBS infection, the recommended dose of Penicillin G is 100mg/Kg daily in 2 divided doses for neonates.
- All antimicrobial treatments used for treating unknown infections in neonates must include adequate GBS cover.
- If mother decline antibiotics their babies must be observed in hospital for signs of sepsis for at least

Stop antibiotics after 48 hours if cultures negative and no evidence of sepsis

MRSA

Staphylococcus aureus is a bacterium normally found in the nose or skin of 30% of the general population. Meticillin Resistant *Staphylococcus aureus* (MRSA) - previously called Methicillin - is a strain of *S. aureus* that is resistant to the antibiotic flucloxacillin and also to all of the beta-lactam antibiotics i.e. all penicillins, cephalosporins and carbapenems.

MRSA, like Meticillin Sensitive *Staphylococcus aureus* (MSSA) can cause a spectrum of illness ranging from asymptomatic colonisation through to life threatening infections e.g. bacteraemia.

MRSA is now endemic in most UK hospitals. The patients and the public are increasingly seeing MRSA and rates of MRSA infections as indicators of quality care. They require reassurance that all healthcare professionals are taking reasonable and sensible precautions to minimise risk. Control is necessary in order to limit the spread and to minimise the clinical impact.

Mode of Transmission
MRSA can be spread in the following ways:

- By direct person to person contact usually by the contaminated hands of health care staff.

- In dust particles that settle on furniture and fixtures and fittings in the clinical environment. The physical environment of any health care institution should be clean and cleaning is everyone's responsibility not just the domestics (A matrons charter; An action Plan for Cleaner Hospitals)

- Endogenous or self-infection occurs when a micro-organism colonising a site on the host enters another site and establishes infection.

General Principles
The general principles of infection control apply to all wards/departments and are applicable to the control/management of communicable infections, including MRSA.

- Hand decontamination is the single most effective way to prevent the spread of Health Care Associated acquired micro-organisms. Therefore, correctly performed hand washing/hand decontamination as per the Trust Hand Hygiene Policy is essential.
- High standards of aseptic techniques, especially when managing indwelling medical devices such as cannulae and catheters.

Aseptic Non Touch Technique (ANTT)
Aseptic Non Touch Technique (ANTT) is a method used to prevent contamination of susceptible sites by micro-organisms that could cause infection. This is achieved by ensuring that only sterile equipment and fluids are used and the parts of components that should remain sterile eg: the tip of intravenous connectors are not touched or allowed to come into contact with non sterile surfaces. ANTT must be applied for any invasive procedure. For example:

- Wound Care
- Urinary Catheterisation
- PVC Insertion

Continuing Care
All intravenous cannulae and associates devices must be removed as soon as there is no further indication for their use.

Site Inspection
There must be regular observation of the site for signs of the phlebitis / infection and action must be taken upon findings.

Please note: this list is not exhaustive. (See Trust ANTT policy and Peripheral Intravenous Cannula Standard operation procedures guidelines on intranet)

Further reading

- EPIC 2 National Evidence-Based Guidelines for Preventing Healthcare Associated Infections in NHS Hospital in England.2007
- Screening for meticillin-resistant *Staphylococcus aureus* (MRSA) colonisation, Saving lives programme Department of Health 2007.
- Royal College of Nursing (2004 Revision) Methicillin Resistant *Staphylococcus aureus* (MRSA) Guidance for Nursing Staff.

Extract from HEFT "Meticillin Resistant *Staphylococcus aureus* (MRSA) Policy"
Sarah Bashford, Infection Prevention and Control Midwife
February 2010

Neonatal Infection

Neonates are at high risk of infection because of immature immune systems, fragile skin and invasive procedures. Infection is broadly divided into early onset sepsis (<48 hours of life) and late onset sepsis. Presenting features are ubiquitous and may include any system.

It is essential to know the susceptibility of clinical isolates of the neonatal unit and to tailor antibiotics therapy depending on this. All antibiotic regimes should be limited to the minimum course possible.

Neonatal Unit Antibiotic regimen (refer to neonatal formulary for doses & interval)

Blood cultures must always be taken using aseptic technique before commencing or changing antibiotics. Occasionally other cultures, eg CSF, urine, line tip, respiratory secretions will be requested.

Early onset sepsis (<72 hours):

- Intravenous Benzylpenicillin and gentamicin are given for a suspected infection when a baby is **first** admitted. The only exceptions to this are:
- Suspected meningitis- use cefotaxime (100mg/kg) and ampicillin
- Suspected Listeria monocytogenes - use ampicillin and gentamicin.

Late onset sepsis (>72 hours)

1st line:

- Flucloxacillin and gentamicin should be used for treatment when a baby is >72 hours or has previously been treated with benzylpenicillin.
- Flucloxacillin & gentamicin should still be the treatment of choice even if a central catheter is in-situ. In occasional circumstances the decision may be made to move to second line treatment but this must be after discussion with a registrar or consultant.

2nd line:

- Tazocin (Piptazobactam) and vancomycin may be used if there is no clinical improvement on first line treatment. It is essential that vancomycin levels are therapeutic (10-15mg/L) and dose adjustments will need to be made to achieve this.

3rd line:

- Meropenem and Vancomycin are rarely used and should only be started after discussion with the responsible neonatal consultant.

Also:

- Add metronidazole if NEC is diagnosed (and the baby is not already on tazocin)
- Cefotaxime is used instead of Penicillin and gentamicin if there is significant risk of **renal impairment** e.g. if hypoxic-ischaemic encephalopathy
- In a baby who remains persistently sick, consider the risk of gentamicin resistant Gram negative infection. Repeat all cultures and change to Cefotaxime.
- In catheter related sepsis the catheter tip should be sent for culture

Stop antibiotics after 48 hours if cultures negative and no evidence of sepsis

	Level	**Satisfactory Levels**
Gentamicin	Taken prior to 2nd dose	<2mg/L; if level is >2mg/L increase dose frequency (e.g. from 24 hourly to 36 hourly)
Vancomycin	Taken prior to 2nd dose	10-15mg/L if level is low increase dose by 10-15% and repeat level after 2nd dose; if level remains low despite increasing dose consider increasing frequency of dosing (e.g. from 12 hourly to 8 hourly) if level is high, decrease dose by 10-15% and repeat level after 2nd dose; if level remains high consider decreasing frequency of dosing (e.g. from 12 hourly to 18 hourly)

Further reading

1. de Man P et al. An antibiotic policy to prevent emergence of resistant bacilli. Lancet,2000;355:973-978.
2. Isaacs D. Rationing antibiotic use in neonatal units. Arch Dis Child, 2000;82:F1-F2
3. Cunha BA Effective antibiotic-resistance control strategies, The Lancet;1307:1307-1308.
4. http://www.nrls.npsa.nhs.uk/resources/?EntryId45=66271

AP/DP April 2010

Systemic Candidiasis

Epidemiology

Systemic candidiasis is the third most common cause of late-onset sepsis in VLBW infants UK data (National prospective surveillance study) showed an estimated annual incidence of invasive disease of 1.0% (0.8-1.2) amongst VLBW infants and 2.1% (1.65-2.57) in ELBW infants. The vast majority of cases are of late onset (>72hrs after birth). Mortality rates range from 25-40%, greater than that from bacterial infection.

Definition of Invasive disease is (one or more of the following):

1. Culture of fungus from sterile site:
   - Blood (peripheral, not via in-dwelling catheter)
   - Central intravascular catheter ("long-line") tip
   - Urine (SPA or aseptic "in-out" specimen)
   - CSF
   - Bone or joint
   - Peritoneal or pleural space
2. Pathognomonic findings on ophthalmological exam or renal USS or echo
3. Infants with autopsy diagnosis

Signs and symptoms are non-specific and include: temperature instability; respiratory distress; lethargy, apnoeas ± bradycardia; NEC like illness: glucose intolerance, abdominal distension, bilious aspirates and blood in stools.

Risk Factors

- Admission to an intensive care unit with a substantial rate of candidaemia
- Infants born <26 weeks gestation / Birth weight <1000g
- Intubated
- No enteral feeds / Parenteral nutrition / Presence of a central venous catheter
- Falling platelet count, sustained >3 d
- Gut perforation / Abdominal surgery
- Cardiovascular instability requiring pressor support
- H-2 Receptor antagonists
- History of broad-spectrum antibiotic coverage / administration of a 3rd generation cephalosporin
- Negative blood culture result
- Systemic steroids

Treatment

Liposomal Amphotericin

- Start with 3/kg and increase dose as tolerated to maximum 6mg/kg or higher (8-10mg/kg)
- A minimum of 3 weeks will be required but up to six weeks may be necessary
- If isolate is sensitive to Fluconazole, the baby is well and all anti-inflammatory markers have settled, may switch to iv or oral Fluconazole to complete the desired 6-week anti-fungal course. This should be discussed with the attending consultant and the duty microbiologist.

- **Failure to improve** – consider adding 5-flurouracil and/or increasing the dose of limposomal amphotericin (depending on the MIC of the organism). This should be discussed with the attending consultant and the duty microbiologist. Echocandin, may be considered.

Other management

End-organ evaluation:
- Abdominal USS (including Renal USS)
- Cerebral USS
- Lumbar puncture
- Fundoscopy
- Echocardiogram

Remove central lines
Blood cultures at 24-48 hourly intervals to ensure clearance

Prophylaxis

- The UK (as opposed to USA) incidence of fungal infection **does not** justify routine use of prophylactic Fluconazole even in babies of birth weight <1000g . Prophylaxis may be considered in individual babies at high risk of sepsis (see risk factor list). This must be discussed with a consultant first.
- Oral nystatin has been found to be as effective in preventing fungal colonisation in high risk neonates

Further reading

1. Kaufman D et al, Fluconazole prophylaxis against fungal colonisation and infection in preterm infants. N Engl J Med, 2001;345:1660-1666.
2. Candida Infection protocol, Royal Prince Alfred Hospital, NSW.
http://www.cs.nsw.gov.au/rpa/neonatal/

AP/DP March 2010

Lumbar punctures

LPs are performed either as:

1. diagnostic taps when meningitis is suspected or possible
2. drainage procedures in communicating hydrocephalus

Diagnostic taps when meningitis is suspected or possible:

Indications:

1. Clinical suspicion about meningitis
2. Positive blood cultures

Clinical practice:

1. 22g $1^{1}/_{2}$ inch needle
2. Strict aseptic technique
3. Give analgesia if possible (sucrose/EBM)
4. Good flexion of spine
5. LP at lumbar space **above** line joining iliac crests
6. Refer to senior if two failed attempts
7. Take 3 sterile bottles – 2 for microbiology & 1 for protein estimation (biochemistry).
8. Measure blood and CSF glucose
9. Bleep on call microbiology technician when taken
10. Bleep porter – DO NOT pod samples

Response to CSF results:

1. Treat truly suspected meningitis with ampicillin and cefotaxime before culture results
2. Treat > 100 WBC as suspected meningitis
3. If there is a traumatic tap adjustment in white cell count may need to be made, especially if the neonate has a high white cell count.
4. Early onset GBS meningitis may have low CSF white count, especially if baby neutropaenic
5. Post IVH CSF can mimic meningitis results, but treat as meningitis if any doubt

Drainage procedures in communicating hydrocephalus

- In infants with ventriculomegaly CSF drainage may be necessary.
- Record the head circumference and ventricular index prior to draining.

Clinical practice:

1. Points 1 – 10 above still apply.
2. If no CSF obtained – is it non-communicating hydrocephalus? **Discuss with consultant**.
3. Send each specimen for protein and glucose and cell count/culture
4. Initially take 5 – 10 ml of CSF, or less if fontanelle becomes depressed
5. Some larger babies tolerate up to 20 ml per puncture
6. If repeated LPs become necessary, aim for alternate days or less frequently
7. Repeated withdrawal of CSF can cause hyponatraemia. Monitor plasma U&E

8. Results from the DRIFT trial have not shown any benefit of repeated drainage of CSF.

Insertion of LP cannula and stylet.

A recent study from Cambridge[1] showed there is a high correlation (r=0.922) between weight and depth from the skin to the mid point of the spinal canal. From the published figure, the depths at different weights are approximately:

500g → 9.5mm,	1000g →10mm,
1500g →11.5 mm,	2000g →12 mm,
3000g →14mm	4000g →16mm.

Further reading

1. Zubier, Kelsall and Tooley, Neonatal Society, June 2001

AP March 2010

Tuberculosis and BCG vaccination

- New babies who are at risk of contracting Tuberculosis (TB) should receive immunisation with BCG vaccine prior to discharge from the maternity unit, as it is difficult to ensure complete coverage after the child has been discharged home.

- Infants at risk include those whose families originate from Africa, South East Asia including the Indian subcontinent and China, South and Central America, Turkey, Eastern European countries (with the exception of the Czech and Siovak Republics), and countries of the former Soviet Union. This is irrespective of number of generations elapsed since immigration, and includes mixed race babies.

- **At the initial history taking session, all mothers will be asked by the Community Midwife if they have a personal or family history of TB.**

- Infants where a close family member has required treatment for TB in the past 12 months should receive BCG vaccination. These infants should also be discussed with Dr S Welch, consultant in paediatric infectious diseases.

- If antenatal serology is not available, but the mother is judged to be of low risk for HIV BCG should be given.

- BCG vaccine will be administered at the pre-discharge medical examination to those babies who are eligible. The SHO carrying out the examination will undertake this task.

- No preliminary tuberculin testing is necessary. The vaccine supplied will normally be for intradermal administration only; it should **not** be given percutaneously (this is an alternative route in neonates, for which a special vaccine and special equipment is required).

Contraindications to BCG Vaccination

- Positive HIV status. If the mother is known to be HIV positive, BCG vaccination should be withheld.
- No consent
- Any malignancy or immunodeficiency, including family history of inherited immunodeficiency, eg SCID
- Pyrexia
- Septic skin conditions
- Newborn contacts of sputum smear positive TB

Vaccination

- If another vaccine is to be given concurrently with BCG vaccine, they must not be given in the same arm.
- If not given at the same time, an interval of at least 3 weeks should be allowed to lapse between the administration of BCG and another live vaccine.
- No other vaccine should be given into the same arm as the BCG vaccine for 3 months afterwards.
- If the vaccine is inadvertently administered subcutaneously instead of intradermally, this should be recorded in the mother's notes (or the baby's if there are any) for inclusion in the discharge summary. It should be reported to the midwife in charge of the ward and the possibility of abscess formation advised to the mother. The baby's health visitor should be contacted by telephone.
- Every effort should be made to administer BCG during the baby's in-patient stay. The Health Visitor will check that BCG has been administered at the 14 day visit. If it has not been possible to administer BCG in hospital, the child should be referred back to the neonatal secretaries who will arrange for this to be done in a vaccination clinic. Heaf testing should be done prior to the BCG vaccination of infants over the age of 6 months (not 3 months of age)

- Consent to administration of BCG will be recorded in the parent held child health record. The yellow copy is held on the postnatal wards to be sent to Child Health, the green copy is stapled into the hospital notes and the blue copy remains in the record.

GUIDELINES FOR INJECTION OF BCG VACCINE SSI

It is generally accepted that the best method of BCG vaccination is intradermal injection with use of a syringe and a needle. This is the most accurate method because the dose can be measured precisely and the administration can be controlled. Hereby the rate of adverse reactions can be minimized.

BCG (Bacillus Calmette-Guérin) **VACCINE SSI** is a live freeze-dried vaccine for intradermal use.

- The vaccine is stored at 2° to 8° C
- The vaccine is reconstituted with DILUTED SAUTON SSI
- Use a sterile 1.0 ml syringe fitted with a short bevelled needle (25 or 26 G)

DO NOT FREEZE !

Reconstitution of BCG VACCINE SSI
(10 dose vial)

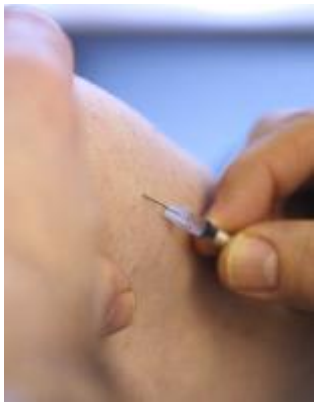
- Transfer exactly 1.0 ml Sauton to the vial using a sterile syringe fitted with a long needle
  Do not remove the rubber stopper
- To suspend the vaccine turn the vial gently upside down a few times –
  DO NOT SHAKE
- The suspension should be homogenous, slightly opaque and colourless

Any reconstituted vaccine not used should be discarded after max. 4 hours.

The site of injection
The recommended site of injection (all age groups) is the deltoid region of the arm, about one third down the upper arm over the insertion of the deltoid muscle.

Dosage of BCG VACCINE SSI

- For infants <12 month **0.05 ml** of the reconstituted vaccine is recommended
- Gently swirl the vial before drawing up each dose
- Draw up slightly more than one dose and remove any air bubbles and extra vaccine



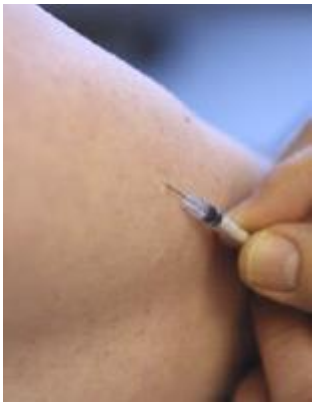
Injection technique

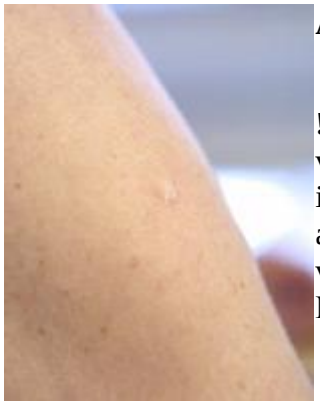
- The skin should not be cleansed with antiseptic before the injection
- Jet injectors or multiple puncture devices should not be used
- The skin is stretched between the thumb and forefinger
- The needle should be almost parallel with the skin surface and the bevel of the needle facing upwards
- The needle should only be inserted approximately 2 mm into the superficial layers of the dermis

Injection technique (continued)

- The vaccine is given slowly
- You will feel a slight pressure as you press the plunger, and a small flat swelling will appear (very similar to a mosquito bite)

! If the skin does not swell or you feel you can press the plunger too easily, then the vaccine is probably given too deeply. You can try to draw back the needle into correct position and give the rest of the vaccine.





After injection

- The swelling will disappear within 10-15 minutes

! If there is no swelling **never give a second dose** of vaccine. Vaccination given too deeply gives adequate results in turns of clinical protection. However a larger scar, an abscess or enlarged lymph nodes may result from a vaccination given to deeply.
Make a note on the person's chart for careful follow-up.

This information is from a Danish web site: http://www.ssi.dk/sw4145.asp and is included in the Southern West Midlands BCG guidelines.

Further reading

1. NICE guidance on TB
2. 'The Green Book' chapter 32 - Tuberculosis (updated Nov 2007)
3. TB Immunisation website
4. WHO list of TB prevalence in different countries

5. Medicines for Children 2003 RCPCH Publications Ltd. London

Herpes Simplex Infections

Neonatal herpes simplex virus (HSV) infection is a rare but potentially devastating condition. It can follow primary or recurrent maternal infection, or be acquired postnatally through direct contact with infected secretions. Transplacental transmission is unusual, and perinatal infection is usually acquired during vaginal delivery through an infected birth canal.

The relative contribution of primary and recurrent maternal infection to neonatal disease, the prevalence of neonatal infection and the proportion of neonatal disease associated with HSV-1 and HSV-2 varies between countries. Primary maternal infection close to term is estimated to lead to neonatal infection in about one third of cases, and to be about 10 times more likely to result in neonatal infection than a recurrence of maternal infection. Although oral infection is predominantly associated with HSV-1, and genital infection with HSV-2, there is considerable crossover, and genital HSV-1 is common, and becoming more so. The natural history of genital HSV-1 and HSV-2are different, and reactivation is more frequent following HSV-2. There is some evidence that prior infection with HSV-1 is partially protective against the acquisition of HSV-2, and it usually prevents the severe clinical manifestations associated with primary infection. Overall, the majority of women who have had genital HSV are probably not aware of the fact, as both primary infection and reactivation can be asymptomatic.

Infants who present with disease *localised* to the skin, eye and/or mouth (SEM) have the best prognosis and death is unusual, although impairment can occur, possibly associated with sub-clinical CNS infection. Those who present with acute *disseminated* HSV infection have multiple organ involvement, including the liver, lungs, gastrointestinal tract and CNS; the likelihood of death is high, and most survivors have severe handicap. Infants with *encephalitis* alone often present late; mortality is over 50%, and the long-term prognosis poor for survivors. Disseminated disease and encephalitis can present with or without SEM infection; early diagnosis is vital in all cases since antiviral therapy can significantly affect outcome.

Surveillance of neonatal HSV was undertaken through the BPSU in 1986-1991. The estimated prevalence of infection was then 1.65/100,000 (CI 1.3-2.0/100,000). HSV-1 and HSV-2 were reported in equal proportions. Approximately equal numbers of infants presented with localised, disseminated and CNS infection.

Care of Newborns Whose Mothers Have Primary Active Genital Lesions:

- **LSCS should be performed immediately on a woman who presents with ruptured membranes for < 4 – 6 hours and active genital lesions at term, or when the fetal lungs are thought to be mature.** This may reduce the risk of neonatal herpes. The risk/benefit when the membranes have been ruptured for > 4 hrs is uncertain.

- A history of maternal genital HSV or recurrence of genital HSV is not an absolute indication for LSCS.

- Women with recurrent genital herpes lesions and confirmed rupture of membranes at term should be advised to have delivery expedited by the appropriate means.

- Scalp monitors should be avoided in infants of women suspected of herpes.

- Infants born by such a LSCS to a mother with active genital herpes should be observed, and cultures performed. Start acyclovir if the infant's cultures are positive, or if HSV is strongly suspected.

- In a woman with preterm rupture of the membranes and active genital lesions, the best course of action is unclear. Obstetric options include:
  (1) expectant management with/without IV acyclovir to the mother.
  (2) delay of delivery to give dexamethasone to mature of the fetal lungs;
  (3) LSCS

- Infants born by LSCS after PPROM should be treated as though delivered vaginally.

- **Infants of mothers with a first episode, primary genital infection, delivered vaginally have a high risk of infection (33% to 50%).** This is increased further by prematurity, instrumental delivery, and lacerations during delivery. **They should have IV acyclovir 20mg/kg 8 hourly from birth** (check renal function).

- Delay circumcision in boys at risk for approximately 2 months of age.

- Neonatal HSV infection can occur up to 6 weeks. Beware of late rashes/illnesses.

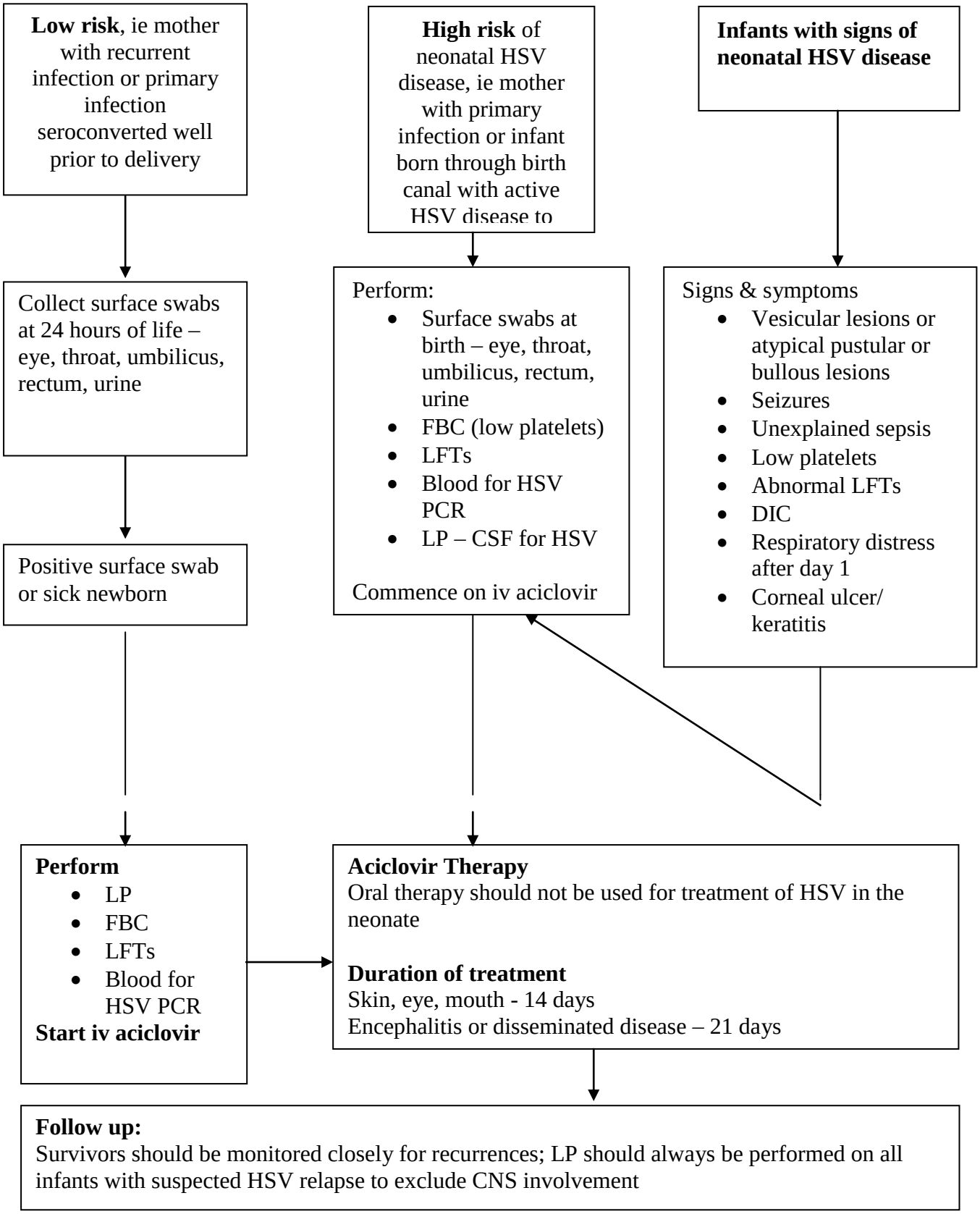
Infected Staff.

- Transmission of HSV in NNUs from infected staff to babies has occurred. The risk from staff with cold sores or who are asymptomatic oral shedders is low. Those with cold sores who have contact with infants:
  1. should cover and not touch their lesions,
  2. should hand wash carefully,
  3. must not kiss or nuzzle babies.
- Transmission of HSV infection from personnel with genital lesions is unlikely as long as good hand washing practice is maintained.
- Those with a herpetic whitlow should not care for babies.

Household Contacts with Infected Persons.

- Transmission of HSV to babies has occurred within families. Those with cold sores or a whitlow should be counselled about the risk and should avoid contact of their lesions with babies.

Herpes Simplex Virus Infections in Pregnancy : Neonatal Management



Perinatal Chickenpox (Varicella)

Varicella, the primary infection with herpes varicella zoster virus (VZV), in pregnancy may cause maternal mortality or serious morbidity. It may also cause fetal varicella syndrome (FVS), previously known as congenital varicella syndrome and varicella infection of the newborn, which includes syndromes previously known as congenital varicella and neonatal varicella.
FVS is characterised by one or more of the following: skin scarring in a dermatomal distribution; eye defects (microphthalmia, chorioretinitis, cataracts); hypoplasia of the limbs; and neurological abnormalities (microcephaly, cortical atrophy, mental restriction and dysfunction of bowel and bladder sphincters). It does not occur at the time of initial fetal infection but results from a subsequent herpes zoster reactivation *in utero* and only occurs in a minority of infected fetuses.

Full term delivery

If maternal infection occurs at term, there is a significant risk of varicella of the newborn. Elective delivery should normally be avoided until 5–7 days after the onset of maternal rash to allow for the passive transfer of antibodies from mother to child.
Neonatal ophthalmic examination should be organised after birth. Neonatal blood should be sent for VZV IgM antibody and later a follow-up sample after 7 months of age should be tested for VZV IgGantibody.

VZIG is recommended for the following:

- Infants whose mothers develop chickenpox (but not herpes zoster) in the period 7 days before to 7 days after delivery. VZIG can be given without antibody testing of the infant.
- VZ antibody negative infants exposed to chickenpox or herpes zoster in the first 7 days of life. Either an antenatal or infant blood sample should be tested to determine VZ antibody status.

The infants should be monitored for signs of infection until 28 days after the onset of maternal infection
VZIG is of no benefit once neonatal chickenpox has developed. Neonatal infection should be treated with acyclovir following discussion with a Neonatologist/ virologist.

Premature infants

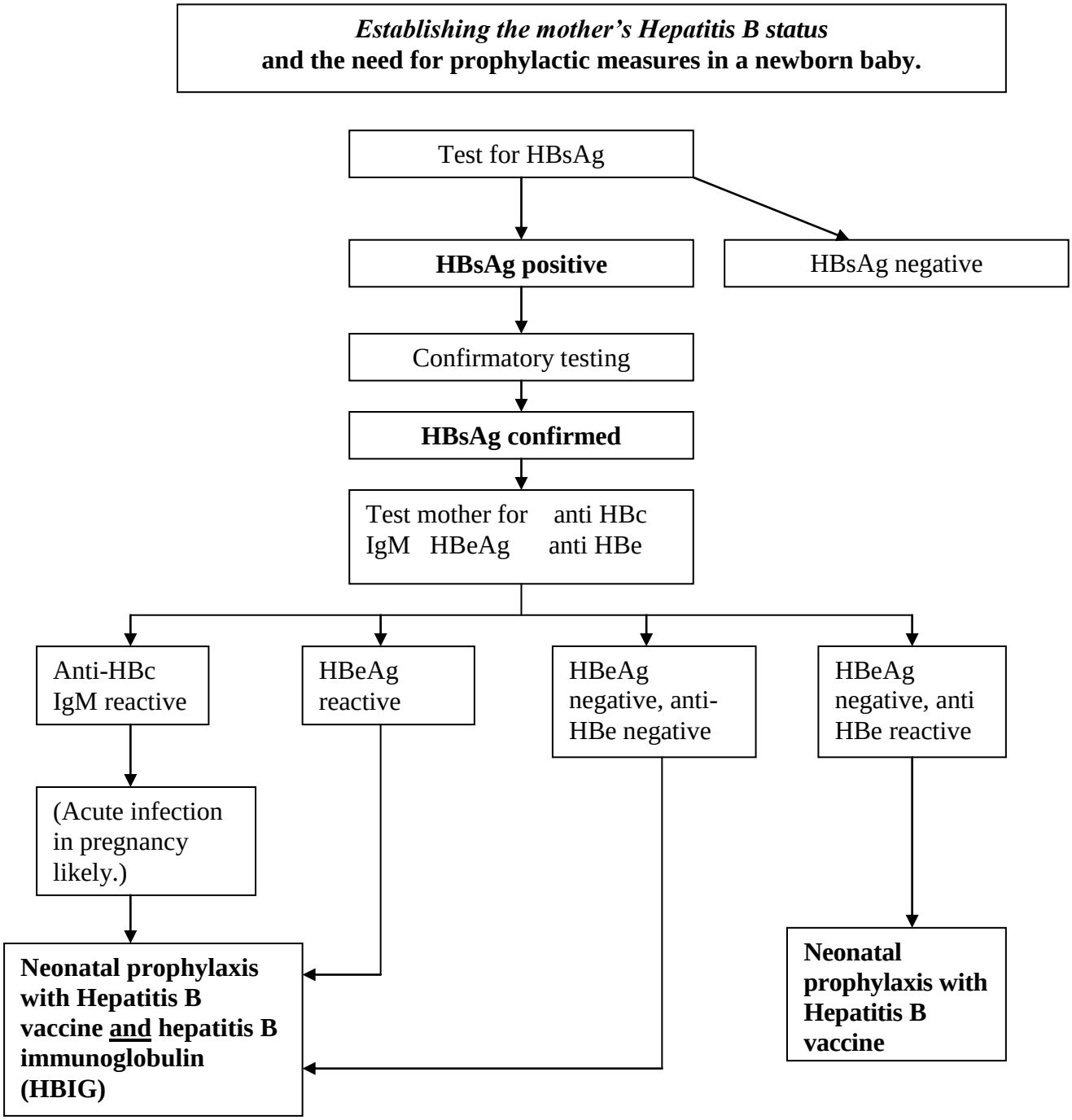
VZIG is recommended for the following:

- VZ antibody negative premature infants exposed to chickenpox or herpes zoster while still requiring intensive or special care nursing.
- Exposed premature infants born before 28 weeks gestation or weighing < 1000gms at birth can be given VZIG regardless of a positive maternal history as transfer of maternal antibodies may be inadequate before the third trimester (although in practice the majority will be VZ antibody positive).

Premature infants born after 28 weeks or weighing more 1000gms at birth may be VZ antibody negative despite a positive maternal history, particularly if they are more than 60 days old or have had repeated blood sampling with replacement by packed red cell infusion. Serological testing to determine VZ antibody status of premature infants is therefore recommended rather than reliance on birth weight, gestational age and maternal VZ antibody status.

RCOG Greentop Guideline No 13; September 2007

Hepatitis B in pregnancy



This algorithm is a simplified version of "Hepatitis B in Pregnancy", Issue no: 2.1 issued 02.06.03 by the Standards Unit, Evaluation and Standards laboratory on behalf of the Advisory Committee on Virology

Additional groups for HBIG as well as vaccine now include babies with birthweight under 1.5Kg and babies born to mothers with HBV DNA levels of >1,000,000IU/ml (for mothers who may be under the care of a liver or infectious disease physician.)

Hepatitis B**: Information and Guidelines for Vaccination**

1) Vertical transmission of Hepatitis B is from carrier (HBsAg +ve) mothers to their babies. In the West Midlands the transmission rate without intervention is about 15% .

2) The risk is highest in South East Asian/Chinese mothers who are "e antigen" (HBeAg) positive. Vertical transmission from them is 70-90%. Transmission is low in Europeans who are only HBsAg positive, and intermediate in Afro-Caribbean and Asian mothers.

3) However, fatal cases of neonatal hepatitis have occurred in e antigen negative/anti-HBe positive mothers. Horizontal transmission within families whose members are carriers may also occur and vaccination should be offered to these babies.

4) **VACCINATE EVERY BABY BORN TO A HEPATITIS B CARRIER MOTHER.**

5) **Babies of HBeAg + ve mothers and mothers who do not have anti-HBe and mothers who may have had acute hepatitis B in pregnancy must also receive hepatitis specific immunoglobulin which will provided by the virology laboratory. This should be given at the same time as the vaccine, but in another limb.**

6) See the algorithm for how the mother's hepatitis B status is classified and when to give vaccine alone or vaccine and immunoglobulin at the same time.

Practical issues:

1) Before birth a paediatrician and an obstetrician are contacted by the Health Protection Unit. The letters state whether babies should also receive immunoglobulin, and must be consulted prior to immunisation. Check that it confirms your interpretation of the algorithm. The letter is sent to the neonatal secretaries and kept in the secretaries office (yellow folder).

2) Make sure the mother has seen the "Hepatitis B Virus Information for Pregnant Women"

3) Infants of carrier mothers should receive four doses of Hepatitis B vaccine. Ask parent to sign consent on Hepatitis Immunisation Programme form:

- **First dose**: within 6 hours of birth: Engerix 10 micrograms IM + immunoglobulin if indicated
- **Second** at 1 month
- **Third** at 2 months
- **Fourth** at 12 months

Immunoglobulin is stored in a labelled fridge on the NNU

4) The top copy remains in the PHCR. All subsequent copies are returned to the Immunisation section as each immunisation is completed.

The 2nd, 3rd and 4th doses are to be given in the immunisation clinic. This appointment is made for 4 weeks time by the neonatal secretaries. A final appointment is made at 12 months for Hep B antigen and Hep BsAg antibody testing. Antibodies to Hep BsAg indicates response to vaccination.

AP/Elizabeth Boxall March 10

Hepatitis C

Unlike hepatitis B, universal antenatal screening for Hepatitis C is not performed as there is no effective intervention in terms of patient treatment or management that will reduce the risk of transmission from mother to baby. However, some high risk pregnant women are known to be infected with hepatitis C and may be referred to a liver unit during pregnancy.

- If the mother has a PCR test and the viraemia is > 10^6 iu/ml, the risk of transmission is high, if the PCR is negative the risk is very low.
- All babies born to hepatitis C infected mothers should be seen at 3 to 6 months in a clinic for PCR testing, and then again at 12 months for serology, followed by PCR if that if serology is positive. Please arrange with Dr S Welch, consultant in paediatric infectious diseases.
- If both are positive, the baby will be referred to the Liver Unit at BCH.

SW March 2010

Congenital Syphilis

In UK the incidence of newly diagnosed syphilis cases in women, increased from 0.2 (1999) to 0.7 /100,000 (2003). The highest rate (2.5 per 100,000) was in the 20-24 age group. The risk of congenital syphilis diminishes as maternal syphilis advances, with the rate of vertical transmission in untreated women being 70-100% for primary syphilis, and 40% for early secondary syphilis. Late secondary rarely leads to Congenital Syphilis.

Serology

1) **Treponemal Tests**
    a) **TPHA** Treponema pallidum particle agglutination test
        (i) Remain positive for life in syphilis patients; no correlation with disease activity. False positives occur in other spirochetal diseases e.g. leptospirosis, and Lyme disease.
        (ii) Transplacental treponemal antibodies may persist for greater than 1yr.
    b) **EIA**: Treponemal enzyme immunoassay to detect IgG, IgG & IgM or IgM
2) **Nontreponemal Test: VDRL** - Venereal disease research laboratory test.
    a) **False negative** results may occur in infants with acquisition of congenital syphilis in late pregnancy and in individuals with extremely high antibody titres prior to dilution (prozone phenomenon).
    b) **False positive** results may occur in connective tissue disease (SLE) EBV, VZV, Hepatitis, measles, TB, SBE, malaria, lymphoma and Wharton jelly contamination of cord blood samples.
    c) **Correlates with disease activity.** A 4 fold decrease in titre suggests effective treatment. A 4 fold increase after treatment suggests relapse or re-infection.
    d) Transplacental nontreponemal antibodies usually wane in 4-6 months

TPHA antibody tests remain positive for life following syphilis regardless of treatment. VDRL tests are high in primary and early secondary syphilis infections as well as congenital syphilis. VDRL levels low in treated, late secondary and latent syphilis; low risk of congenital syphilis.

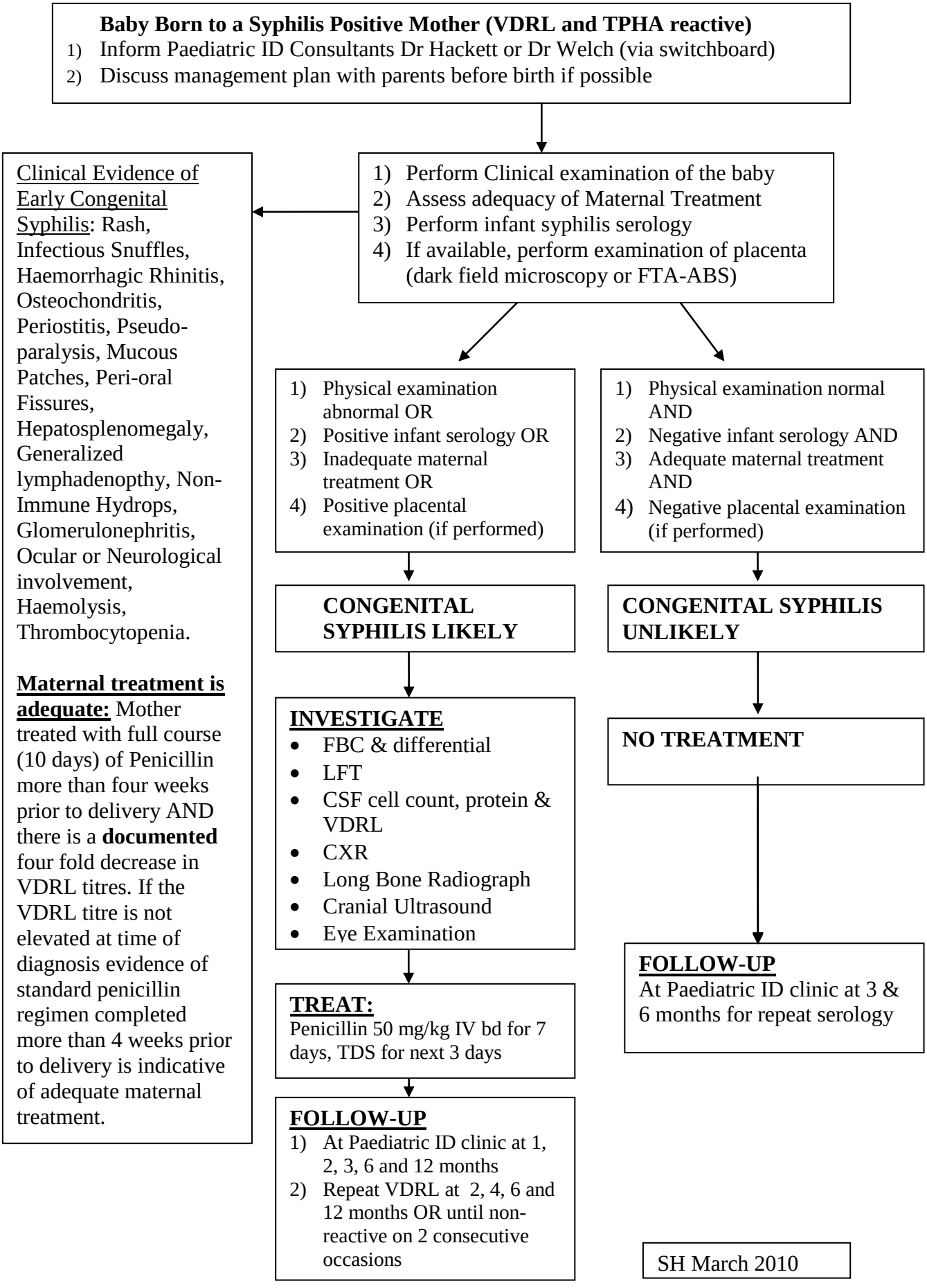
Important

1. Mother's partner should be screened for other STD's, HIV & Hepatitis B & C
2. Older siblings should be screened clinically for congenital syphilis

Further reading

- Doroshenko, J Sherrard, A J Pollard. Syphilis in pregnancy and the neonatal period. International J STD and AIDS. 2006;17; 221.
- American Academy of Pediatrics. Syphilis. In: Pickering LK (Ed). Red Book: 2006 Report of Committee on Infectious Diseases, 26th edn. Elk Grove Village, IL, USA: American Academy of Pediatrics, 2003, pp. 595-607
- UK national Guidelines on the Management of Early Syphilis, Clinical Effectiveness Group (Association for Genitourinary Medicine and the Medical Society for the study of Venereal Diseases

Management of Congenital Syphilis



Vaccinations

The standard UK vaccination programme (from 4/9/2006) is listed below. All babies who are still on the unit should be vaccinated as per this schedule. The schedule has been truncated at 12 months.
Written consent must be obtained before vaccinating a baby.

Early Childhood Immunisation Programme.

When to immunise	What is given	Vaccine and how it is given
Two months old	Diphtheria, tetanus, pertussis, polio and *Haemophilus influenzae* type b (DTaP/IPV/Hib)	One injection (*Pediacel*)
	Pneumococcal conjugate vaccine (PCV)	One injection (*Prevenar*)
Three months old	Diphtheria, tetanus, pertussis, polio and *Haemophilus influenzae* type b (DTaP/IPV/Hib)	One injection (*Pediacel*)
	Meningitis C (MenC)	One injection (*Neisvac C* or *Meningitec*)
Four months old	Diphtheria, tetanus, pertussis, polio and *Haemophilus influenzae* type b (DTaP/IPV/Hib)	One injection (*Pediacel*)
	Pneumococcal conjugate vaccine (PCV)	One injection (*Prevenar*)
	Meningitis C (MenC)	One injection (*Neisvac C* or *Meningitec*)
Around 12 months	*Haemophilus influenzae* type b, Meningitis C (Hib/MenC)	One injection (*Menitorix*)

Respiratory Syncytial Virus

Preventing babies getting RSV is important. Many ex-premature babies who were ventilated get severe bronchiolitis. On the NNU watch out for families (particularly young brothers and sisters) with coughs and sneezes during the RSV season. Counsel them about the risks to their baby, and advise them how to reduce the risk:

- No visits from brothers and sisters or other relatives with sore throat, cough or coryza. (It is difficult to exclude parents)
- No kissing of babies if someone has a sore throat, cough or coryza

Regional Guidelines for Palivizumab to prevent RSV Infection in ex Preterm Babies

Prophylaxis with Paluvizimab should be considered fir the child's first RSV season ONLY, for infants <12 months (corrected gestational ages) at the start of the 1st RSC season AND

who fall within one (or more) of the high risk categories defined in the policy (high risk CLS, high risk CHD or immune deficiency).

High Risk Categories

1. **High risk chronic lung disease**

a. CLD in preterm infants – defined as preterm infants who continue to require oxygen at 36 weeks corrected age
b. CLD infants who are not preterm but who are at higher risk – defined as use of home oxygen as a proxy for CLD in children with conditions including:
   Pulmonary hypoplasia due to congenital diaphragmatic hernia
   Other congenital lung abnormalities
   Interstitial lung disease
c. CLD infants with significant co-morbidities

2. **High Risk Congenital Heart Disease (CHD)**

Defined as:

- Haemodynamically significant acyanotic CHD including pulmonary hypertension
- Cyanotic or acyanotic CHD PLUS significant co-morbidities

3. **Immune deficiency**

Organisational Issues

Wherever possible arrangements are made to allow vial sharing. Prior to the start of the RSV season the name and current each infant who requires prophylaxis should be given to the prophylaxis clinic coordinator and prophylaxis will be arranged on a monthly basis until the end of the RSV season.

Although these guidelines are current at the time of publishing, it is the responsibility of the named consultant for each infant to ensure that the infant is eligible at that time to receive Paluvizimab.

AP April 10

Further reading

Paluvizimab Policy v2; Specialised Commissioning team (west Midlands) Dec 2010

SKIN PROBLEMS
AND THEIR MANAGEMENT

Management of The Collodion or Harlequin Baby

These are severe expressions of congenital ichythoses.

a) Collodion baby – a shiny collodion- like membrane covers the baby at birth.

b) Harlequin ichthyosis – thick plaques with fissures cover the skin often binding down the digits making limbs look deformed. Sometimes digit tips are necrotic.

In the vast majority of cases the skin is the only organ involved. 10% of collodion babies may eventually have normal skin.

The major risks to the baby are **dehydration, infection and hypothermia**.

With modern neonatal intensive care mortality is around 10%.

1. Admit any collodion/ harlequin baby to intensive care. Inform consultant on-call. Contact Dr Goodyear (41826) and the Paediatric dermatology nurses (41818) immediately or the next morning if born at night.
2. Nurse in an incubator with maximum (90-100%) humidity.
3. All staff should wash hands and wear sterile gloves every time before touching the baby.
4. IV lines and blood sampling should be avoided if at all possible as this increases the infection risk. If required umbilical catheters should be used.
5. Babies should be enterally fed, by NGT, OGT or mouth. Consider starting fluids at 90mls/kg/day. Monitor fluid balance meticulously by twice daily weights and urine output (nappy weighing not catheterisation). Fluids should be increased as required (may need 250mls/kg/day).
6. Take multi–site skin swabs on admission and every 3 days afterwards or when infection is suspected.
7. Wash or bathe daily with Dermol 600 added to the water.
8. Prophylactic antibiotics should not be used unless there are other indications.
9. Apply emollient i.e. 50/50 white soft paraffin/liquid paraffin very sparingly twice daily using an aseptic technique. Discuss any further treatment with Dr Goodyear.
10. If the baby's vital signs alter suspect **skin infection**. Treat without delay with systemic antibiotics. The oral route may be used if the infection is very localised. Remember MRSA as a cause of infection. This can occur on day 1.
11. Start acitretin for harlequin ichthyosis 1mg/kg/day given orally in 2 divided doses.
12. Take 2 mls of blood into EDTA for DNA studies
13. An urgent ophthalmology opinion should be sought regarding management of ectropion. Lacrilube eye ointment should be applied 2 hourly.
14. Prescribe paracetamol 15mg/kg one hour before handling. The condition is usually not as painful as it looks. Morphine should not be given routinely and it's use must be discussed with a Consultant.
15. Encourage the family where possible to help care for their baby. This is a very difficult time for the parents and caring for their child may help them to deal with the situation.

Updated by HG Feb 2010

Care of Newborn Baby with Epidermolysis Bullosa

Epidermolysis Bullosa is a genetically inherited condition which results in blistering where there is friction or trauma to the skin. In newborn babies damage may be extensive often caused by kicking in utero or the trauma of delivery and large areas may be denuded of skin.

Handling

Although these babies are delicate they can, and should be handled. Further damage can be minimised by careful handling avoiding friction.
Do not push your hands under the baby, the shearing force may cause blistering. Instead roll the baby away from you and allow to gently roll back on to hands to lift. Alternatively, lift the baby on the mattress or cushion they are lying on.
An arm or leg can be held quite firmly as direct pressure should not cause problems but do not allow the baby to twist in your grip as the resulting friction may induce blistering.
Nurse in a cot or bassinette unless for other reasons, such as prematurity, the baby needs to be in an incubator.
Nurse baby on a spenco incubator pad or gamgee covered with a soft or silk sheet.

First Aid

Wrap denuded areas in cling film if no other dressings are immediately available. There is an EB box kept on NNU at Heartlands and Solihull hospital.
DO NOT use any adhesive dressings, plasters, electrodes, skin temp probes etc. If any adhesives are accidentally used, soak off with 50/50 WSP or use Apeel adhesive remover.
Umbilical cord - the clamp should be removed and replaced by a ligature.
The name band of the child should be taped to the baby's cot or clothing.
When dressings are in place dress in a soft Babygrow with the seams on the outside to reduce friction to the skin.
Use 50/50 WSP on the nappy area, place a liner or Conti Soft Wipe inside the nappy to protect skin on legs from elasticised edges on nappy.

Dressings

Give adequate analgesic cover half an hour prior to dressing changes
For example: Paracetomol , Codeine, **or** Oramorph.

Cover raw areas with Mepitel and use Aquacel over this to absorb any exudate. Hold in place with tubifast or Soft one or Mepitac.
Dress affected fingers and toes separately, if possible, using small pieces of Mepitel and Soft one.
NB: It may be easier to dress one limb at a time to reduce chances of legs kicking together and causing further damage.

Blisters

Burst blisters as they arise using a sterile needle- Taking the needle parallel to the skin surface, pierce the blister taking the needle through and out of the other side so that fluid can drain out easily. Take care to leave the roof of the blister intact if possible.

Gentle pressure with a gauze swab can be used to encourage fluid to drain but be aware that too much pressure may encourage the blister to spread.

Feeding

Oral feeding should be established as normal. Breast-feeding should be encouraged if mother wishes to do so. If the baby is to be bottle fed a normal bottle can be used with a soft teat, latex teats are usually softest. The teat should be moistened with water before feeding or smeared with a very small amount of white soft paraffin to reduce friction. Alternatives such as soft bottles or Haberman feeders may be considered if problems are encountered.
Blisters may occur in the mouth or throat, they usually burst spontaneously and may bleed. Teething gel may also be used if the mouth is sore.

Do not pass a nasogastric tube unless absolutely necessary, if needed use a silk tube, secure using mepiform or by twisting the tube round a piece of blue or yellow line tubifast. DO NOT use any adhesive tape.

NB. If adhesive tapes have been used anywhere **do not pull off**, the skin is likely to come away with the tape. Apply 50/50 white soft paraffin to loosen tape and ease off gradually and carefully.

Bathing

Babies with EB are much more vulnerable when naked and care should be taken when bathing to ensure that the baby does not do any further damage to the skin e.g. by rubbing feet together.
For babies with large areas of erosion bath in a solution of potassium permanganate (Take care to dissolve the tablets fully as any granules left may cause burning of the skin on contact). 1 tablet should be dissolved in 4 litres of water. Dermol 500 can be used as a soap substitute.
Pat dry using very soft towels or sheets. Dermol 500 can again be used as an emollient
Examine skin for new blisters and burst as above.

Observations

Take temperature via axilla taking care to lift arm to avoid any shearing against the skin.
Avoid using any adhesive skin probes.
Do not use any adhesive probes. Probes can be fixed with Mepitac.

Clothing

Dress in soft, front-fastening babygrow turned inside out so that there is no damage caused by seams and label.

Guthrie or equivalent test must be done but is best done from a venous sample rather than heel prick

CONTACT NUMBERS

Heartlands Paediatric Dermatology nurses: Pauline Scialdone and Jan McMahon 41818 or mobile
Dr Helen Goodyear 41826
EB Nurses - Ruth Ward 0121 333 8224 e-mail: eb.team@bch.nhs.uk
Natalie Hadley
Dawn James
Emma McAndrew

Sheila Richards
Consultant - Dr Celia Moss 0121 333 8226

Helen Goodyear February 2010

Extravasation of IV fluids

Prevention:

- Drips should be sited without a dressing over the tip of the cannula.
- Do not use scalp veins draining towards the forehead and face.
- All drip sites should be checked visually on an hourly basis.
- Drips can tissue at low pressures without triggering the pressure alarms on the IVACs.

Concerns:

- Doctors must be informed immediately of all IV fluid infiltrations except for those of:
  10% dextrose (± added sodium/potassium*),
  5% dextrose (± added sodium/potassium*),
  Dextrose saline (± added potassium*),
  N saline (± added potassium*).

  * all in concentrations **up to** 3mmol/60ml or 25mmol/500 ml bag, higher concentrations should be regarded as harmful and reported

- Solutions that are particularly harmful to subcutaneous tissues are:
  TPN solutions
  Calcium containing solutions
  Strong potassium solutions
  Sodium bicarbonate
  15% or 20% dextrose
  Blood
  Dopamine, dobutamine, adrenaline, noradrenaline infusions

Treatment of infiltrations from intra-venous infusions:

- Turn off the drip.
- Keep the cannula in place!
- Aspirate as much fluid as possible back through the cannula.
- Draw the cannula back 1 – 2 mm then -

- For non-vasopressor infiltrates that, in addition to swelling, have become either red, blanched, darkened or blistered:

  1. Reconstitute a 1500 unit vial of hyaluronidase with N saline.
  2. Draw up 0.1 ml (150 units) of this solution in a 1ml syringe.
  3. Dilute this 0.1ml to 1 ml with 0.9 ml of N saline.
  4. Inject slowly into the cannula, so that it enters the same tissue plane as the infiltrate.
  5. If the cannula has been removed, inject 0.2ml of hyaluronidase into the swelling at each of 4 or 5 sites around the infiltrated area.

6. Hyaluronidase is most effective if administered within 2 hours of infiltration, but can be beneficial up to 12 hours later. Only one dose can be used.
7. Remove the cannula and elevate the limb if possible.

- <u>For vasopressor infiltrates with local blanching or vasoconstriction of the limb distal to the infiltrate:</u>

1. Treat as above for a non-vasopressor infusion.
2. Suck up 0.1 ml of 2% nitro-glycerine ointment into a 1 ml syringe.
3. Apply the ointment over the blanched area.
4. Monitor carefully for changes in heart rate and blood pressure: absorption and systemic effects are likely to be most marked in babies with very thin skin.
5. Repeat 8 hours later if needed.

- 2% Nitro-glycerine ointment in the same dose may also be applied around the wrist for vasospasm secondary to radial artery cannulation, after removal of the cannula.

MW 2005 , AP 2010

HEARTLANDS:
Contacting a paediatric physiotherapist:

Urgent referral is via bleep 2240 between 0800 and 1600
At weekends and bank holidays ask switchboard to contact the on-call physio. There is no need for out of hours calls.

Developmental dysplasia of the Hip

- **Paediatric SHOs are the primary screeners for abnormalities, and the neonatal team as a whole is responsible for this programme, which has been developed together with Mr Glithero, consultant paediatric orthopaedic surgeon.**

- All babies with a clinical diagnosis of congenital dislocation of the hip must be referred to the physiotherapists for urgent ultrasound and treatment at the next Wednesday clinic in Solihull. Call extension 44044 or 45446

- The physiotherapists at Heartlands will not examine the babies, and nor will they provide 24hr cover 365 days a year.

- **The Hip Ultrasound Clinic** is run by physiotherapists. The service's lead consultant is Mr Glithero. The clinic is held only at Solihull Hospital on Wednesday mornings in the Childrens Outpatient Department. The usual policy is to screen before splinting.

  Referral to the clinic is made by completing an Ultrasound Request Form for a scan of the hips, and leaving it in the post-natal ward's 'Hip Book' AND by leaving the baby's name, number and reason for referral in that book. Sign it!

- The request form will be picked up by the physios and a appointment for the clinic will be sent out (<6 weeks). **Write in the 'hip examination' section of the notes that the referral has been made**.

- Once the form is completed and the name is in the book, Mr Glithero and the physios will take over care of the baby's orthopaedic 'problem'. No paediatric follow up is needed unless other problems co-exist.

It is expected that 5 – 10% of all babies will be referred to the Hip Clinic.

The following groups of babies should be referred:

HISTORY: Breech presentation in the third trimester
Any baby who has undergone external cephalic version for breech presentation
Family history of developmental dysplasia of the hip. (DDH)

ASSOCIATED ABNORMALITIES:

Oligohydramnios
Genu recurvatum
Torticiollis
Any other skeletal anomaly

ABNORMAL FINDINGS:

Clicky hips or any other concern

NB babies with DDH must be referred immediately (see above)

Parents should be counselled about the importance of attending for the scan.
The information that should be provided includes:

- Mother's name and address
- GP name and address
- Baby's PID, DOB, gestational age – particularly if premature – and sex
- Type of delivery
- Reason for hip scan request
- Date of request
- Doctor's name, signature and bleep number

Talipes

True talipes: the inability to place the foot plantigrade on a flat surface.

True talipes should be seen by a trained paediatric physiotherapist within 48 hours of birth. Therefore referral must be prompt - refer 8am to 4pm weekdays by bleep, evenings and weekends contact paediatric physiotherapists via switchboard. **Do not discharge a true talipes without prior agreement from the physiotherapist**.
Treatment (strapping/plasters) and referral to Mr. Glithero are the responsibilities of the physiotherapists.

Positional talipes: Whatever the posture of the foot at rest, talipes is positional if the foot can be placed plantigrade on a flat surface in mid position without force.

Positional talipes needs no treatment. Reassure the mother. No physiotherapy/orthopaedic referral is needed for the foot problem.

Retinopathy of Prematurity

Introduction

The evidence-based guideline for the screening and treatment of ROP was developed by a multidisciplinary guideline development group (GDG) of the Royal

College of Paediatrics & Child Health (RCPCH) in collaboration with the Royal College of Ophthalmologists (RCOphth), British Association of Perinatal Medicine (BAPM) and the premature baby charity BLISS. These guidelines form a framework for screening for ROP. Infants with developing ROP and those that may require treatment demand an individualised management plan founded on expert assessment.

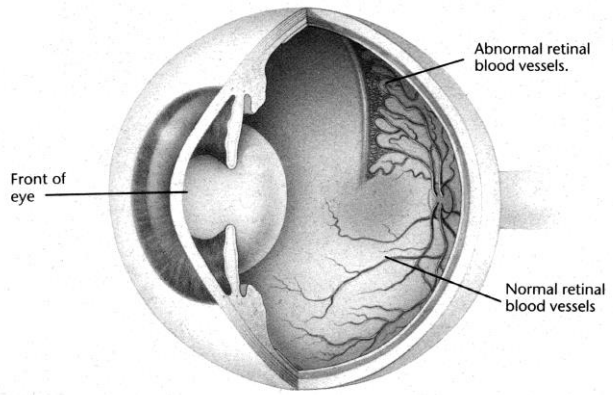
WHAT IS RETINOPATHY OF PREMATURITY?

Retinopathy of prematurity (ROP) occurs in premature babies when abnormal blood vessels and scar tissue grow over the retina. The retina is the light-detecting layer of cells at the back of the eye that allows us to see.

This condition usually affects premature babies weighing less than three pounds at birth. An ophthalmologist (eye physician and surgeon) can detect ROP during an examination of the baby's eyes in the neonatal unit (NNU) or nursery.

WHAT CAUSES ROP?

The causes are not completely understood. The retinal blood vessels in some very small premature babies seem to develop abnormally during the first few weeks of life.



Examples of normal and abnormal retinal blood vessel growth.

It was once thought that oxygen, given to almost all premature babies, was responsible for ROP. Evidence now indicates this is not true. How premature the baby is and his or her birth weight are factors which influence the risk of developing ROP. For example, a baby who weighs three pounds at birth has a much lower chance of developing ROP than an infant weighing two pounds or less.

WILL ROP AFFECT VISION?

It is difficult to predict whether the eyesight will be affected when the diagnosis of ROP is made. In many infants, the abnormal blood vessels shrink or go away without affecting vision. In others with more extensive disease, bleeding and scar tissue may lead to distortion or detachment of the retina. Moderate or even severe loss of vision may result.

Nearsightedness (myopia) is common in children with ROP. Glasses may improve the vision of these children. Amblyopia (lazy eye) is more common in children with ROP.

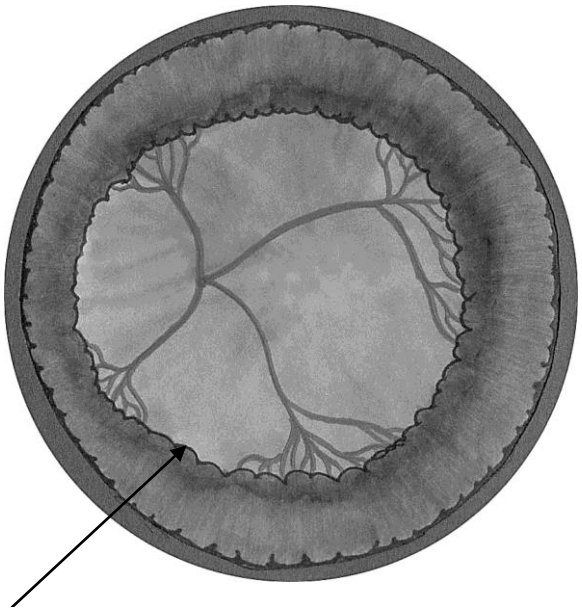
CAN ROP BE PREVENTED?

Unfortunately, laboratory and clinical research has not yet found a way to prevent ROP in all babies. The sophisticated medical care provided in modern neonatal intensive care units has

improved the survival chances of very small babies. Because more premature infants survive, ROP has become more common over recent decades.

CAN ROP BE TREATED?

Most babies' eyes with ROP do well without any treatment. In more severe cases, laser treatment is given. A very small bright laser light is shone into the eye through the pupil. The baby is anaesthetised during the procedure. When successful, treatment can slow down or reverse the abnormal growth of blood vessels and scar tissue in more severe ROP.
When needed, treatment markedly lowers the chance of severe vision loss.



Laser treatment is given to the unhealthy edges of the retina (dark area in this diagram)

It may be necessary for an ophthalmologist to examine a baby frequently while the infant is in the NNU or nursery before he or she can recommend treatment. Important factors in the decision include where ROP is located in the eye, how severe it is and how it is progressing.

It takes approximately one week for the benefit of the laser surgery to appear. If the condition does not improve at that stage then sometimes further laser treatment is recommended.
Even with treatment, there is still risk of serious vision loss.
Periodic eye examinations will be necessary as the baby grows if treatment has been given, to ensure that his or her vision is developing as normally as possible.

Who should be screened?

ROP screening will be carried out for all infants who are:

- Born before 32 weeks gestation (up to 31 weeks and 6 days) **OR**
- Born with a birth weight less than 1501g

Please make sure that the details of infants who fulfil the above criteria are entered into the ROP diary on admission to the neonatal unit.

When should the first screening be performed?

- **Babies < 27 weeks gestation** - first screen 30/31 weeks (first screening opportunity in the week after baby reaches 30 weeks, and before 31 weeks gestational age)
- **All other babies who need screening** - At 4 - 5 weeks of age (first screening opportunity in the week after the baby reaches 28 days, and before 35 days of age)
- If a baby is unable to have screening at the time indicated because of clinical or organisational circumstances, the screening should be rescheduled within one week of the intended examination. Please make a record of this decision to postpone ROP examination and the reason in case notes
- In all babies the first screen should be done before discharge home

How often will be babies be screened?

- All babies included in the screening programme will be screened at least every two weeks until they are discharged from ROP screening
- Some babies who may be developing ROP will be screened weekly. This is determined by the ophthalmologist
- The ROP screening form should be promptly filed into their respective case notes after ophthalmologist documents the vascularization of the retina and the stage of ROP

LASER TREATMENT

Preoperative Preparation

- Inform the parents about the need for surgery. Consent should be obtained by the operating ophthalmologist(Ms Kipioti)
- Move the baby into a room dedicated for laser treatment where the operation is to be performed
- The room is closed to all visitors and staff members not looking after the baby
- A sign must be displayed on the doors indicating that a laser procedure is taking place and that no one should enter
- Doors and windows are covered by special blinds for laser safety
- Baby should be nil by mouth for 4 hours prior to the set time of surgery. An intravenous infusion should be commenced
- Instill dilating eye drops (Cyclopentolate 0.5% and Phenylephrine 2.5%) into each eye at 30 and at 0 minutes prior to surgery

- Intubate and ventilate baby to ensure a safe airway. Sedate with 50 micrograms/kg of diamorphine IV, and paralyse with Pancuronium 100 micrograms/kg IV
- Maintain baby on continuous monitoring and hourly recordings of HR, BP, Saturations and Temperature

Intraoperative

- Monitor vital signs and possible complications during the procedure
- Registrar or consultant to stay with baby

Postoperative Care

Wean from ventilation as able, return baby to main ITU. Allow paralysis to wear off, consider further analgesia

- Continuous monitoring and hourly recording of cardiorespiratory status, blood pressure, SpO_2, and skin temperature
- Restart enteral feeds when the baby wakes
- Keep parents informed of baby's progress
- Postoperatively instill MinimsDexamethasone 0.1% qds and G.Cyclopentolate 0.5% tds in each eye.
- Follow-up will be arranged by the ophthalmologist

References

1-UK Retinopathy of Prematurity Guideline May 2008, Royal College of Paediatrics and Child Health, Royal College of Ophthalmologists, British Association of Perinatal Medicine & BLISS 2008

Jaundice

Introduction

Jaundice is one of the most common conditions requiring medical attention in newborn babies. Approximately 60% of term and 80% of preterm babies develop jaundice in the first week of life, and about 10% of breastfed babies are still jaundiced at 1 month of age. In most babies with jaundice there is no underlying disease, and this early jaundice (termed ‘physiological jaundice’) is generally harmless. However,

there are pathological causes of jaundice in the newborn, which, although rare, need to be detected. Such pathological jaundice may co-exist with physiological jaundice.

Risk Assessment

Factors that influence hyperbilirubinaemia

- gestational age under 38 weeks
- a previous sibling with neonatal jaundice requiring phototherapy
- mother's intention to breastfeed exclusively
- visible jaundice in the first 24 hours of life

Risk factors for kernicterus/or adverse sequelae

- a serum bilirubin level greater than 340 micromol/litre in babies with a gestational age of 37 weeks or more
- a rapidly rising bilirubin level of greater than 8.5 micromol/litre per hour
- clinical features of acute bilirubin encephalopathy

When to measure

Measure and record the serum bilirubin level urgently (within 2 hours) in all babies with suspected or obvious jaundice in the first 24 hours of life. Continue to measure the serum bilirubin level every 6 hours for all babies with suspected or obvious jaundice in the first 24 hours of life until the level is both:

- below the treatment threshold
- stable and/or falling

How to measure

- use a transcutaneous bilirubinometer in babies with a gestational age of 35 weeks or more and postnatal age of more than 24 hours
- if a transcutaneous bilirubinometer is not available, measure the serum bilirubin
- if a transcutaneous bilirubinometer measurement indicates a bilirubin level greater than 250 micromol/litre check the result by measuring the serum bilirubin
- always use serum bilirubin measurement to determine the bilirubin level in babies with jaundice in the first 24 hours of life
- always use serum bilirubin measurement to determine the bilirubin level in babies less than 35 weeks gestational age
- always use serum bilirubin measurement for babies at or above the relevant treatment threshold for their postnatal age, and for all subsequent measurements
-

Management
Visual/clinical examination

In all babies:

- check whether there are factors associated with an increased likelihood of developing significant hyperbilirubinaemia soon after birth

- check the naked baby in bright and preferably natural light
- examination of the sclerae, gums and blanched skin is useful across all skin tones
- Measure and record the bilirubin level urgently (within 6 hours) in all babies more than 24 hours old with suspected or obvious jaundice

Investigations

- Serum bilirubin
- FBC
- blood group (mother and baby)
- DAT (Coombs' test)
- Consider
  Septic screen
  G6PD (taking account of ethnic origin)

Note: Do not subtract conjugated bilirubin from total serum bilirubin when making decisions about the management of hyperbilirubinaemia (see management thresholds in the threshold table http://www.nice.org.uk/nicemedia/live/12986/48679/48679.pdfand treatment threshold graphs)

Information for parents or carers on treatment

Offer parents or carers information about treatment for hyperbilirubinaemia, including:

- anticipated duration of treatment
- reassurance that breastfeeding, nappy-changing and cuddles can usually continue

Encourage mothers of breastfed babies with jaundice to breastfeed frequently, and to wake the baby for feeds if necessary.

Provide lactation/feeding support to breastfeeding mothers whose baby is visibly jaundiced.

Phototherapy

- Use serum bilirubin measurement and the treatment thresholds in the threshold table and treatment threshold graphs when considering the use of phototherapy. http://www.nice.org.uk/nicemedia/live/12986/48683/48683.xls

- In babies with a gestational age of 38 weeks or more whose bilirubin is in the 'repeat bilirubin measurement' category in the threshold table, repeat the bilirubin measurement in 6–12 hours.

- In babies with a gestational age of 38 weeks or more whose bilirubin is in the consider phototherapy' category in the threshold table, repeat the bilirubin

measurement in 6 hours regardless of whether or not phototherapy has subsequently been started

- Do not use phototherapy in babies whose bilirubin does not exceed the phototherapy threshold levels in the threshold table and treatment threshold graphs.

During phototherapy

- repeat serum bilirubin measurement 4–6 hours after initiating phototherapy
- repeat serum bilirubin measurement every 6–12 hours when the serum bilirubin level is stable or falling

Stopping phototherapy

- Stop phototherapy once serum bilirubin has fallen to a level at least 50 micromol/litre below the phototherapy threshold (see threshold table) and treatment threshold graphs
- Check for rebound of significant hyperbilirubinaemia with a repeat serum bilirubin measurement 12–18 hours after stopping phototherapy. Babies do not necessarily have to remain in hospital for this to be done

Type of phototherapy to use

1-Single phototherapy

Term babies

Use conventional 'blue light' phototherapy as treatment for significant hyperbilirubinaemia in babies with a gestational age of 37 weeks or more unless:

- the serum bilirubin level is rising rapidly (more than 8.5 umol/litre per hour)
- the serum bilirubin is at a level that is within 50 umol/litre below the threshold for which exchange transfusion is indicated after 72 hours (see the threshold table and treatment threshold graphs)

Do not use fibreoptic phototherapy as first-line treatment for hyperbilirubinaemia for babies with a gestational age of 37 weeks or more

Preterm babies

Use either fibreoptic phototherapy or conventional 'blue light' phototherapy as treatment for significant hyperbilirubinaemia in babies less than 37 weeks unless:

- the serum bilirubin level is rising rapidly (more than 8.5 umol/litre per hour)
- the serum bilirubin is at a level that is within 50umol/litre below the threshold for which exchange transfusion is indicated after 72 hours (see treatment threshold table and treatment threshold graphs)

2-Continuous multiple phototherapy treatment for term and preterm babies

Initiate continuous multiple phototherapy to treat all babies if any of the following apply:

- the serum bilirubin level is rising rapidly (more than 8.5 umol/litre per hour)

- the serum bilirubin is at a level within 50 umol/litre below the threshold for which exchange transfusion is indicated after 72 hours (see threshold table and treatment threshold graphs)
- the bilirubin level fails to respond to single phototherapy (that is, the level of serum bilirubin continues to rise, or does not fall, within 6 hours of starting single phototherapy)

General care of the baby during phototherapy

- place the baby in a supine position unless other clinical conditions prevent this
- ensure treatment is applied to the maximum area of skin
- monitor the baby's temperature and ensure the baby is kept in an environment that will minimise energy expenditure (thermoneutral environment)
- monitor hydration by daily weighing of the baby and assessing wet nappies
- support parents and carers and encourage them to interact with the baby
- Give the baby eye protection and routine eye care during phototherapy.
- Use tinted headboxes as an alternative to eye protection in babies with a gestational age of 37 weeks or more undergoing conventional 'blue light' phototherapy

Feeding and hydration during phototherapy

During conventional 'blue light' phototherapy:

- using clinical judgement, encourage short breaks (of up to 30 minutes) for breastfeeding, nappy changing and cuddles
- continue lactation/feeding support
- do not give additional fluids or feeds routinely

Maternal expressed milk is the additional feed of choice if available, and when additional feeds are indicated

During multiple phototherapy:

- do not interrupt phototherapy for feeding but continue administering intravenous/enteral feeds
- ontinue lactation/feeding support so that breastfeeding can start again when treatment stops.

Maternal expressed milk is the additional feed of choice if available, and when additional

Exchange transfusion

Use a double-volume exchange transfusion to treat babies:

- whose serum bilirubin level indicates its necessity (see threshold table and treatment threshold graphs) **and/or**
- with clinical features and signs of acute bilirubin encephalopathy

Following exchange transfusion:

- maintain continuous multiple phototherapy
- measure serum bilirubin level within 2 hours and manage according to threshold table and treatment thresholds graphs

Other treatments

Use intravenous immunoglobulin (IVIG) (500 mg/kg over 4 hours) as an adjunct to continuous multiple phototherapy in cases of Rhesus haemolytic disease or ABO haemolytic disease when the serum bilirubin continues to rise by more than 8.5 micromol/litre per hour

Prolonged jaundice

In babies with a gestational age of 37 weeks or more with jaundice lasting more than 14 days, and in babies with a gestational age of less than 37 weeks with jaundice lasting more than 21 days:

- look for pale chalky stools and/or dark urine that stains the nappy
- measure the conjugated bilirubin
- carry out a full blood count
- carry out a blood group determination (mother and baby) and DAT (Coombs' test)

Interpret the result taking account of the strength of reaction, and whether mother received prophylactic anti-D immunoglobulin during pregnancy.

- carry out a urine culture
- ensure that routine metabolic screening (including screening for congenital hypothyroidism) has been performed

Follow expert advice from BCH about care for babies with a conjugated bilirubin level greater than 25 micromol/litre because this may indicate serious liver disease.

Conjugated and total bilirubin must be measured to exclude biliary atresia

These babies are seldom emergencies who need to be seen the same day. Arrange for them to be seen in a clinic

Main contact is the Neonatal Unit secretaries on extension 42719 or

If 'phoned by a midwife or GP please ask the following 7 questions:

i) Is the baby well?
ii) Is the baby feeding well and gaining weight?
iii) Is the baby breastfed?
iv) Is the baby between 21 and 35 days old?
v) Are the stools and urine a normal colour?
vi) Has the bilirubin been measured

- **If the answers to all these questions is yes, and the bilirubin is not at the exchange level,** then the baby can be seen in the next baby clinic at either

Heartlands or Solihull hospitals. Please take all the necessary details and refer on to one of the neonatal unit secretaries.

- **If the answer to any of the questions is no**, then it may be appropriate to see the baby the same day or you may feel it appropriate to see the baby the following day in a clinic providing you are confident that such a space can be guaranteed.

- In general, such babies should **not** be brought up to the Paediatric Assessment Unit unless there are immediate concerns about them

- In the clinic:

    - Check:
        - Exclusively breast fed?
        - Thriving?
        - Correct colour stools and urine?
        - LFTs including conjugated bilirubin
        - FBC and film
        - Thyroid function
        - Stick screen for UTI and check for reducing sugars

Reference:

Neonatal jaundice, National Collaborating Centre for Women's and Children's Health**,** Commissioned by the National Institute for Health and Clinical Excellence May 2010

Blood Transfusion

Introduction

For a full-term infant the blood volume is approximately 80mL/kg. In a pre-term infant this may increase to about 100mL/kg, depending upon gestational age. At term, an infant would be expected to have haemoglobin concentration of 14-20g/dl.

The majority of transfusions are made necessary by the continuous phlebotomy of neonates in order to monitor their progress. Micro techniques, non-invasive monitoring and avoidance of unnecessary testing can significantly reduce the transfusion requirements of neonates.

In sick pre-term infants the rise in haemoglobin may be less than expected following a transfusion of red cells because the transfusion will cause an expansion in plasma volume.

Parents should be informed of any transfusions and the discussion documented in the notes other than in an emergency resuscitation. An early discussion for infants of less than 1500g is appropriate and should cover any transfusions for the first month of life.

When to transfuse

0-24 hours of age Haemoglobin below 12g/dl, irrespective of gestation. Establish cause of Anaemia

Acute blood loss Transfuse without delay as dictated by clinical signs. Use 10-20mls/kg boluses. Transfuse until hypotension corrected and perfusion improved. Aim to replace at least the estimated blood volume loss

Phlebotomy blood loss Iatrogenic blood losses can be considerable in ELBW infants. Blood logs should be kept for these infants especially in the first 1-2 weeks, where phlebotomy losses are highest

The extremely sick infant Where perfusion to the vital organs is impaired such as in hypotension that has not been corrected with standard inotropes, or where oxygenation is profoundly disturbed such as in cyanotic heart disease, PPHN or severe respiratory failure, haemoglobin levels should be kept as near 'normal' as possible, particularly in the acute period of treatment. A minimum level of 13g/dl is acceptable

During the first week of life Any baby receiving respiratory support of any kind (IPPV / CPAP/ oxygen), transfuse to maintain Hb above 12g/dl. For those not requiring any respiratory support, transfuse to maintain Hb above 11g/dl

After the first week of life Any baby with significant lung disease requiring greater than 40% oxygen (presumed to be receiving CPAP or IPPV), transfuse to maintain Hb above 12g/dl. Any baby receiving respiratory support of any kind (IPPV / CPAP /oxygen), transfuse to maintain Hb above 11g/dl. If the baby is stable, growing well and has no signs of clinical anaemia, transfuse to maintain Hb above 7g/dl.

Clinical anaemia Any infant with a Hb below 10g/dl with clinical signs of anaemia e.g. lethargy, feed intolerance, poor feeding, tachycardia, apnoea or poor weight gain, should receive a blood transfusion. However, it must not be assumed that the anaemia is the only possible diagnosis. Careful clinicalexamination and investigation for other clinical scenarios (e.g. sepsis) should be simultaneously undertaken.

What to transfuse

In neonates components for transfusion must be irradiated, CMV negative and leukocyte depleted (all UK blood products have been leukocyte depleted since 2001).

Amount to transfuse

20 mLs/kg over 3-4 hours although more rapid rates should be used in hypovolaemia. Frusemide (2 mg/kg half way through transfusion) should not be given routinely unless there is evidence of symptomatic PDA or volume overload. Please do not stop feeds during transfusion.

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2: Gibson BE, Todd A, Roberts I, Pamphilon D, Rodeck C, Bolton- Maggs P, Burbin G, Duguid J, Boulton F, Cohen H, Smith N, McClelland DB, Rowley M, Turner G; British Committee for Standards in Haematology Transfusion Task Force: Writing group.Transfusion guidelines for neonates and older children. Br J Haematol. 2004 Feb;124(4):433-53

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Quick Summary:

Indication	**Category of patient**	**Timing**	**Clinical Details**
Hb<13	Extremely sick infant	Any	
Hb<12	Intensive care	Day 1 Week 1 After 1 week	All infants IPPV or CPAP or in oxygen FiO2>0.4
Hb<11	Oxygen dependant *or* Early anaemia	Week 1 After 1 week	All infants IPPV or CPAP or supplement oxygen
Hb<10	Signs of anaemia	Any time	Lethargy, apnoea, poor weight gain or tachycardia
Hb<7	Well stable	After 1 week	Growing well in air
Acute blood loss			>10% of blood volume

Normal haematological values in infants

	Term	**Preterm**
Haemoglobin g/l	140−240	140−240
Platelets x 10^9/l	150−450	150−450
PT (sec)	10−16	11−22
APTT (sec)	31−55	28−101
TT (sec)	19−28	19−30
Fibrinogen g/l	1.7−4.0	1.5−3.7

Exchange Transfusion

Introduction

Exchange Transfusion is a procedure performed for the treatment/correction of anaemia, hyperbilirubinaemia, and to remove antibodies associated with red blood cell

haemolysis. Exchange transfusion is a specialist procedure associated with a potential for serious adverse events. As such, it should be undertaken only by staffs who are experienced in the procedure.

INDICATIONS

1-Severe Haemolytic Disease of the Newborn (HDN), to manage:

- Hyperbilirubinaemia (please see bilirubin chart)
- Severe anaemia at birth which may be complicated by cardiac failure (where top-up along may exacerbate overload)
- Remove antibody-coated red cells

2-Severe hyperbilirubinaemia secondary to other causes e.g. atypical maternal antibodies, metabolic disease, G6PD deficiency, sepsis

3-Severe anaemia, particularly if accompanied by cardiac failure

Technique
Exchange transfusions are performed using a one catheter or two catheter push-pull methods.

1. Two Catheter Push-pull Technique

Blood is removed from the artery while infusing fresh blood through a vein at the same rate.

IN	OUT
Umbilical vein	Peripheral artery
Umbilical vein	Umbilical artery
Peripheral vein	Periphery artery
Peripheral vein	Umbilical artery

2. One Catheter Push-pull Technique

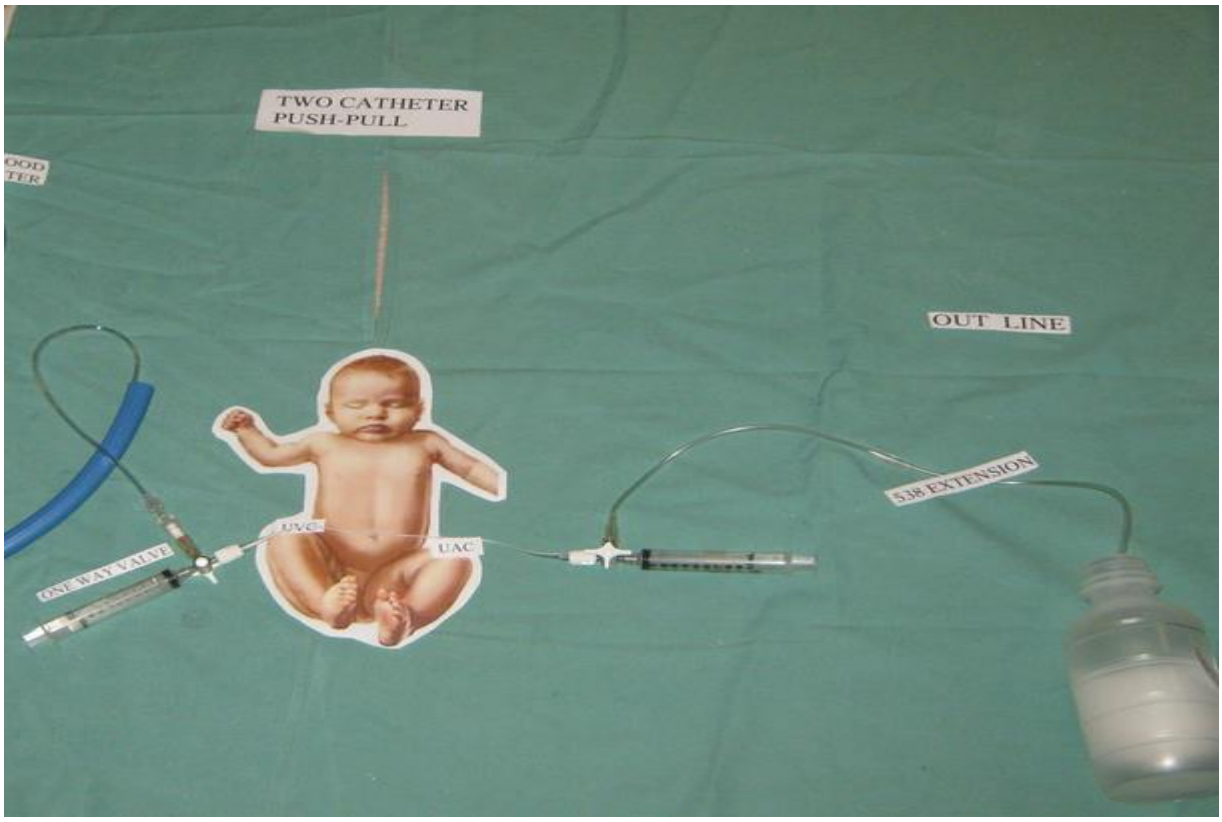
This can be done through an umbilical venous catheter. Exceptionally, an umbilical artery catheter can be used.

Withdraw blood over 2 minutes, infuse slightly faster.

Volume
For a term infant 80–160 ml/kg
For a preterm infant 100–200 ml/kg
Note:
Single-volume exchange' will remove 75% of red cells
Double-volume exchange removes 90% of the initial red cells
For management of hyperbilirubinaemia, a double volume exchange (160−200 ml/kg) is favoured

<1000g	Use 5 ml aliquotes
1001-2000 g	10 ml
>2000 g	15 ml

PROCEDURE:



Blood for Exchange must be:

- Group O neg
- Negative for any red cell antigens to which mother has antibodies; cross-matched with maternal sample
- Plasma-reduced i.e. PCV 0.5-0.6
- $\leq$ 5 days old in CPD anti-coagulant
- CMV-negative
- Leucocyte-depleted
- Irradiated and transfused within 24 hours of irradiation
- Warmed immediately prior to transfusion

REQUIREMENTS
Exchange transfusion set (wardrobe 9)
Blood - Suitable for neonatal use - ie < 2-3 days old, labelled neonatal use - check both labels - if unsure do not use and ring blood bank.
Saline
Sterile gown and gloves
At least 2 staff members

Pre- exchange

- Infant should be nil by mouth
- Insert nasogastric tube and empty stomach prior to commencing exchange
- Treat hypoxia, hypoglycaemia, hypotension, acidosis etc. first: sick neonates must be as stable as possible before exchange
- Investigations: ABO and Rh status, bili, FBC, U&E, LFT, calcium, gas, glucose(***If you may require a blood sample for chromosomes or DNA, take samples now and store in fridge if out of hours***)

Exchange

- Removal and infusion in **series**
- Serial withdrawal versus infusion of aliquots (10 ml)
- Send blood for FBC, U+E, Calcium, SBR, glucose, gas.
- Each cycle over 5 minutes
- Use 3-way sealed unit that comes in the pack
- Extra person to keep written timed record of each withdrawal and infusion PLUS running total, to ensure they are equal and correct total volume is given
- On the last 'out' cycle send blood for FBC, U+E, calcium, SBR, glucose and blood gas
- Continuously monitor and record heart rate, respiratory rate, temperature, saturation
- Record blood pressure every 15mins

Post Exchange

- Continue to monitor heart rate, respiratory rate, temperature, saturation
- Hourly glucose for 2 hours and 6 hourly bilirubin for 24 hours
- Feeding may be restarted 4 hours after exchange

DOCUMENTATION

Informed consent must be obtained - Document in notes

The procedure must be fully documented in the medical notes, including

- Total volume exchanged
- Type of IV/IA access used
- Size of aliquots
- Time taken
- Staff involved
- Complications

POTENTIAL COMPLICATIONS

1. Hypothermia - ensure blood is warmed
2. Hyperkalaemia -monitor ECG for arrhythmias
3. Hypocalcaemia - secondary to citrate in banked blood. May require calcium gluconate infusion
4. Acidosis

5. Arrhythmia
6. Haemodynamic - fluid loss/overload/anaemia/polycythaemia/wrong blood
7. Thrombocytopenia (higher risk with old blood) - may require platelet transfusion
8. Infection
9. Line complications - haemorrhage, embolism, infection
10. NEC

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VG 2010

Polycythaemia and Partial exchange

Polycythaemia is defined as a venous haematocrit greater than 65% and occurs in 0.4 - 4% of newborn infants. Many polycythaemic infants are asymptomatic. When present, the signs and symptoms of polycythaemia are non-specific and include

- feeding problems
- plethora
- lethargy
- cyanosis
- respiratory distress
- jitteriness
- hypotonia
- hypoglycaemia
- hypocalcaemia
- thrombocytopaenia

INVESTIGATIONS

The diagnosis of polycythaemia is made on central or peripheral venous blood with a haematocrit over 65%. Because capillary blood haematocrit is not reliable, a peripheral venous haematocrit should be performed if the capillary haematocrit is above 65%. The haematocrit peaks at 2 hours of age, then falls by 6 hours of age and thereafter

MANAGEMENT

Treatment of polycythaemia is with liberal fluid intake and/or partial exchange transfusion (PET) to reduce the venous haematocrit below 60%. Asymptomatic polycythaemic infants should have their fluid intake liberalized. PET using Normal Saline as the replacement fluid is recommended in symptomatic infants with a haematocrit above 70%

Volume of exchange (ml) = blood volume*(observed - desired haematocrit)/ observed haematocrit

*Term blood volume is 85 ml/kg

A partial exchange is performed with 0.9% saline via a UVC and peripheral vein (or peripheral artery/vein if UVC not available). It can be done 'push-pull' via a single line using 5mls/kg aliquots over 5 minutes, or isovolumetrically when the babies' blood is removed slowly via the UVC or peripheral artery and replaced ml for ml with a continuous infusion of 0.9% saline.

References

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VG June 2010

Thrombocytopaenia

Introduction

Normal platelet count for neonates is 150–400 x 10 9/L. Population–based studies on cord blood suggest 2% of term infants have a platelet count < 150, and 0.2% have platelets < 50.

Persistent thrombocytopenia (e.g. platelets <100) should be investigated and may be a symptom of underlying disease.

The commonest cause of a falsely low platelet count is a clot in the sample. Repeat, if in doubt, especially if capillary sample or difficult peripheral venepuncture.

The natural history of thrombocytopenia in sick infants is very consistent. Platelets fall by day 2 of life in 75% of affected babies, and usually reach their nadir around day 4. By day 10, the platelet count has recovered to normal in 90% of cases.

In an otherwise well term infant, the commonest cause of thrombocytopenia is alloimmune. In a preterm or systemically unwell baby, the commonest cause is sepsis/NEC.

Causes of thrombocytopenia
Isolated thrombocytopenia (i.e. normal Hb, WCC and differential) is almost always due to shortened platelet survival. In preterm infants with maternal PET, platelet production may be impaired

Maternal causes

- Alloimmune (usually maternal anti HPA-1a antibodies from a HPA-1a –ve mother against a HPA-1a+ve foetus). Maternal platelet count is normal
- Maternal autoimmune disease, e.g. ITP, SLE
- Neonate affected by passive auto-antibody transfer in 10 - 40% of cases of maternal ITP
- Risk higher if previous maternal splenectomy
- Correlation between maternal and neonatal platelet counts unreliable in most studies
- Maternal pre-eclampsia
- Congenital infection

Infant causes

- Increased platelet destruction (95% of cases)
- Usually associated with decreased production
- DIC – sepsis, hypoxia-ischaemia, necrotising enterocolitis
- Polycythaemia
- Thrombosis, e.g. catheter- related, renal vein
- Kasabach- Merritt syndrome with giant capillary haemangioma immunological – platelet-associated IgG due to sepsis, rarely to drugs
- Hypersplenism Usually mild effect, can contribute in sepsis
- Reduced platelet production
- Sepsis
- Marrow infiltration – congenital leukaemia (very rare), Transient Abnormal Myeloporesis (TAM) in Trisomy 21, neuroblastoma, steopetrosis
- Marrow aplasia –Fanconi's anaemia (pancytopenia), TAR(thrombocytopenia – absent radii) syndrome
- Dilutional e.g. following exchange transfusion or other massive transfusion of red cells
- Bacterial sepsis often produces a picture of marked thrombocytopenia but only slightly prolonged clotting times. In contrast, hypoxic-ischaemic collapse may produce severely deranged clotting, milder thrombocytopenia but a greater risk of bleeding

Management of thrombocytopenia:

History and examination

• Family history
• Affected siblings in alloimmune thrombocytopenia
• Maternal factors in this pregnancy
• Symptoms suggestive of congenital infection
• Autoimmune disease
• Platelet count
• Drugs taken during pregnancy
• Is the infant haemorrhagic? (Petechiae, purpura, mucosal bleeding)
• Cranial USS should be part of this assessment.
• Symptoms/ signs of current infection
• Congenital anomalies, e.g. TAR, capillary haemangioma
• Central venous catheters

Investigation Infants with platelets persistently < 75 should have the following:

1. Repeat FBC: confirm low platelets, assess trends in Hb / WCC. Is the platelet count stable or falling?

2. Peripheral blood film

3. Blood cultures (consider starting antibiotics if unwell baby or severe thrombocytopenia). Consider full septic screen. A platelet count <30 or abnormal clotting is a contraindication to lumbar puncture

4. Coagulation screen (NB. A coagulation sample reported as 'clotted' reflects an activated sample but not necessarily normal clotting. This sample must be repeated). D-dimers and fibrinogen should be specifically requested, as they may provide the only sign of low grade DIC and so may explain increased platelet consumption

5. Consider maternal platelet count

6. Consider screening for congenital infections

If unexplained thrombocytopenia in baby with no other obvious risk factors:

1. Maternal serum for anti HPA-1a and anti HPA-5b antibodies, plus sample of platelets from father (standard EDTA tube). If antibody –ve but strong clinical suspicion, repeat maternal serum sample
2 – 4 weeks later. Treat without waiting for serology results (but they may be relevant for future pregnancies)

2. Bone marrow aspirate is rarely necessary. It may help in the assessment of persistent severe thrombocytopenia where there is no evidence for peripheral consumption. Discuss with Haematology Consultant.

Treatment

The significance of moderate thrombocytopenia, (ie. platelets 50 –100), is controversial. In such cases, low platelets may reflect a sick baby rather than independently altering outcome.

Very well babies with platelet counts 30 – 50 may be observed rather than giving platelets, so long as they have no clinical signs of bleeding

Prophylactic platelet transfusions for preterm infants with platelets < 150 have been shown not to reduce the incidence or severity of IVH. The exact risk of intracranial haemorrhage in thrombocytopenia is unknown but the following guidelines are based on accepted professional consensus

- Treat cause, e.g. cover for sepsis until cultures –ve
- Transfuse 10-20 ml/kg platelets if
  a) clinically bleeding and platelet count < 50
  b) platelets < 50 in septic or sick infant
  c) platelets <50 if concurrent coagulopathy
  d) platelets < 50 preoperatively
  e) platelets < 30 in well baby with no clinical bleeding

Note:
Bag of platelets should be hung vertically for 10 minutes before transfusion to allow most platelets to settle in the volume being transfused. The bag should then be sampled vertically into the syringe used for administration

• Platelets need to be ABO and Rh compatible but not cross-matched
• All are now leuco-depleted, therefore do not need to be CMV –ve
• In alloimmune disease need to give fully compatible platelets
• In autoimmune disease, platelets of limited value as maternal antibodies also attack transfused donor platelets.

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VG June 2010

Fresh frozen plasma (FFP)

Indications

- Treatment of disseminated intravascular coagulation (DIC)
- Vitamin K-dependent bleeding
- Inherited deficiencies of clotting factors
- Pre-procedure in well babies with abnormal clotting - discuss individual cases with senior
- Volume 15 ml/kg over 60 mins

Efficacy is unpredictable and it may be helpful to recheck clotting function after administration.

Cryoprecipitate

Indications
Cryoprecipitate provides fibrinogen, factor VIII & Von-Willebrand factor. It is used in sick infants with severely deranged clotting and fibrinogen level <1g/l. Early use of fresh frozen plasma may avoid the need for cryoprecipitate.

Volume- 5 ml/kg over 30 mins or as per discussion with Paediatric Haematologist

References

1-BCSH Transfusion Task Force. "Transfusion Guidelines for Neonates and Older Children"
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Metabolic Acidosis – Use of Sodium Bicarbonate

The premature neonate is at great risk of developing metabolic acidosis. Severe metabolic acidosis is associated with adverse clinical outcomes in preterm infants. It is essential to establish whether the acidosis is respiratory with a raised $PaCO_2$ (which requires consideration of airway and ventilation settings) , or metabolic with a normal $PaCO_2$ and a negative base excess, or a combination of both. It is very usual for very preterm infants to have base deficits of upto -5 and these do not necessarily need correction. Serial lactate,

bicarbonate and chloride levels should be monitored and entered in the flow chart in the notes. Persistently high lactate levels are associated with poor outcome. Urine pH should be tested to look for increased renal bicarbonate losses.

Important causes of metabolic acidosis in neonates:

- Perinatal asphyxia
- Sepsis
- Hypotension
    - Hypovolaemia eg large IVH
    - Low cardiac output and poor tissue perfusion
- Hypothermia
- Clinically symptomatic PDA (may be the only manifestation)
- Renal bicarbonate losses due to immature kidneys
- Inborn error of metabolism
- Hyperchloraemia

Apart from correction of significant metabolic acidosis with alkali therapy as outlined below it is essential to identify and correct the underlying cause for the acidosis. If the result is unexpected or if a major clinical decision is to be made on the basis of venous or capillary blood gas values an arterial blood gas should be obtained.

Bicarbonate therapy: Consider treatment in infants with a pH < 7.20 and a metabolic acidosis greater than -5 . Sodium bicarbonate is the alkali most frequently used when correcting metabolic acidosis. It is usually give intravenously to preterm infants but is well absorbed from the gastrointestinal tract.

It can be given over 20-30 minutes or as a slow infusion over 8-12 hours. Slow infusion of bicarbonate is felt to be preferable to rapid infusions for the following reasons:

- Slower correction of ongoing losses rather than repeated boluses.
- Slower infusions have a reduced risk of intraventricular haemorrhage in preterms although evidence for this is not robust.
- Slower infusions minimise fluctuations in cerebral haemodynamics.

Remember that repeated infusion of sodium bicarbonate may cause hypernatraemia.

Use sodium bicarbonate 8.4% and dilute 50:50 with water (= 4.2%). Do not use 10% Dextrose as this increases osmolality of the infusion. 4.2% sodium bicarbonate has 0.5 mmol bicarbonate per ml.

Maximum concentration used = 0.5mmol/ml .

Dose of sodium bicarbonate:
Full correction = base deficit x 0.3 x weight (kg) = mmol of sodium bicarbonate
Half correction = half of full correction

Oral sodium bicarbonate for late metabolic acidosis
Can give 2-3mmol/kg/day of sodium bicarbonate with feeds in otherwise well babies who are acidotic due to increase bicarbonate losses from immature renal tubules (check urine pH).

Example Prescription of IV Sodium Bicarbonate

5mmol 8.4% Sodium Bicarbonate with 5ml Water for injections – 5mmol/10ml
Run at 0.1 – 1.0ml/hr equivalent to 0.05 - 0.5mmol/hr.

Example:
Wt= 0.50kg. pH < 7.20 and a base excess of -10 and PaCO2 within normal ranges.
Full correction 10 x 0.3 x 0.5 = 3mmol.
At a rate of 0.5ml/hr = 0.25mmol/hr → therefore fully corrects over 12hours.

Full correction can be given over 1 – 12 hours depending on clinicians' discretion.
Half correction can be given over 30minutes to 6hours depending on clinicians' discretion.

We prefer to correct over a longer period of time and have a continuous infusion to correct for ongoing losses. Continuous infusions can be discontinued after normalisation of blood and urine pH and a base excess less than -2.

Contraindications and Precautions
Respiratory or metabolic alkalosis.
Not recommended for hypercapnia or hypernatraemic states.
Caution in infants with renal impairment.
No rapid infusions of $NaHCO_3$.

Adverse Effects
Venous irritation, soft tissue injury at the site of IV injection.
Increased serum sodium.
Hypercapnia and respiratory acidosis – ensure effective ventilation.
Hypocalcaemia.
The adverse effects of sodium bicarbonate are largely associated with the use of inappropriately excessive doses, infusion rate or concentrations of sodium bicarbonate.

Alkalinisation of total parenteral nutrition:
Chloride-free (i.e. addition of acetate) TPN can be used for extreme preterm babies and those with a metabolic acidosis. The use of acetate in total parenteral nutrition for premature infants reduces the severity of the acidosis and incidence of hyperchloraemia..

THAM (tris-hydroxymethylaminomethane):
This can be viewed as an alternative to sodium bicarbonate with the potential advantages of not causing hypernatraemia and hypercarbia. Consider THAM infusion instead of bicarbonate if serum sodium is > 140. THAM acts as a proton (hydrogen ion) acceptor ; combines with hydrogen ions and their associated anions of acids (eg lactic acid). The resulting salts are then renally excreted. However, it provides a higher osmolar load in equimolar doses to sodium bicarbonate and can cause depression of ventilation and hypoglycaemia, hyperkalemia and thrombophlebitis and venospasm. Extravasation may cause sloughing of the skin and should be treated as per extravasation guideleine. It has not been subjected to randomised trials and anecdotally is not thought to be as effective as sodium bicarbonate in correcting acidosis.
One mmol of THAM is equivalent to one mmol of sodium bicarbonate.

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Negrine/JS2010

Inborn errors of metabolism (IEM)

Introduction

These conditions are important because although individual inborn errors are rare, overall approximately 1 in 2000 newborn infants will present with an IEM. Secondly prompt recognition of an IEM may be essential to prevent permanent organ injury, especially the brain, or in some cases to prevent death. Whenever a diagnosis of IEM is being considered in an acutely ill child obtain advice from the consultant in metabolic medicine at BCH.

Phone number of consultant on-call at BCH for Inborn Metabolic Disorders is 07919 537125

Clinical aspects:

When should one consider an IMD?

Prenatal

1-Fatty Liver of Pregnancy

Seen in pregnancies where the fetus has a fatty acid oxidation disorder. Though rare, an IMD is more likely in pregnancies with fatty liver of pregnancy than in those with HELLP syndrome. Suggested investigation in the newborn baby and mother is urine for organic acids and blood (Li-Hep)/blood spot on Guthrie card for acylcarnitine analysis.

2-**Dysmophic features on pre natal scan**

Seen in infants with dysmorphic presentations of IMD (see below), eg agenesis corpus callosum, abdominal wall defects, renal cysts, cardiomegaly etc. Suggested investigation in the newborn baby is urine for amino acids and organic acids. Blood(Li-Hep)/blood spot on Guthrie card for acylcarnitine analysis.

3-**Hydrops fetalis**

If an obvious cause for the hydrops foetalis is not apparent (for e.g- Rhesus disease),an IMD should be considered. Suggested investigation in the newborn baby is urine for glycosaminoglycan and oligosaccharide electrophoresis and serum for transferrin isoelectric focusing.

Neonatal IMD

The infant with an IMD may present in one of the following ways. The symptoms /signs in most newborns with IMD are non-specific. Be mindful of the family history and especially a past history of a previous infant with a recognised or undiagnosed severe neonatal illness which may have been an IMD.

The clinical syndromes can be;

- Acute metabolic encephalopathy
- Metabolic acidosis
- Hypoglycaemia
- Jaundice and liver dysfunction
- Dysmorphic features
- Cardiac disease
- Hypotonia
- Neonatal intractable seizures

1-Acute metabolic encephalopathy

- Energy deficiency or circulating toxic metabolites may cause cerebral dysfunction (for e.g- organic acids, ammonia, leucine).

- Infants may be normal at birth because of maternal clearance of these metabolites in pregnancy. A symptom –free interval of a few days is often present in IMDs in the neonatal period but his is variable from a few hours- several days.

- Non-specific symptoms /signs of encephalopathy can range from lethargy, poor feeding, seizures, alterations in muscle tone, cerebral edema, and intracranial haemorrhage to sudden death. IMDs should be considered at the same time as sepsis in the differential diagnosis.

- Respiratory irregularities such as Apnoea and tachypnoea may provide a clue rto an underlying IMD. Metabolic acidosis and hyperammonaemia lead to tachypnoea. Maple syrup urine disease may present with apnoea.

- Persistent vomiting

2- Metabolic acidosis - The anion gap

The anion gap is the Na concentration minus the sum of the chloride and bicarbonate concentrations, normally between 5-15 mEq/L. In the presence of an acidosis an increased anion gap indicates an increase in the presence of organic acid and a normal gap in the presence of an acidosis suggests a loss of buffer.

Metabolic Acidosis	
Increased anion gap (>15 mEq)	*Normal anion gap (<15 mEq)*
Acute renal failure IEM Lactic acidosis Late metabolic acidosis Toxins	Renal HCO3 loss RTA, diuretic, preterm Gut HCO3 loss, eg diarrhoea Dilutional acidosis Hyperalimentation acidosis

3- Hypoglycaemia

- Should raise a suspicion of an endocrine defect or IMD, especially if persistent

- Test urine for ketones in all cases of hypoglycaemia. Ketones may be normal/low /undetectable even in normal unaffected neonates

- Look for clues to causes such as hemi-hypertrophy, macrosomia, hepatomegaly, IUGR etc

4- Jaundice and liver dysfunction

- If a newborn has liver dysfunction (low albumin, deranged clotting and liver enzymes) contact the liver team or the IMD team at BCH immediately

5- Dysmorphic features

- Especially peroxisomal diosorders with severe hypotonia and high forehead

- Glutaric Accidaemia ll with hypertelorism, high forehead, abdominal wall defects, hypospadias, rocker bottom feet and enlarged kidneys.

- Smith- Lemli Opitz syndrome due to a disorder of cholesterol biosynthesis associated with low levels of plasma cholesterol and elevation of the precursor 7 dehydrocholesterol gives rise to cleft palate, long philtrum, epicanthus, congenital heart disease, hypospadias and polydactyly/syndactyly, severe mental impairment and abnormalities of myelination.
- Eye abnormalities especially cataracts (eg galactosaemia). Dislocated lenses in molybdenum co factor deficiency, sulphite oxidase deficiency, homocystinuria.

6- Cardiac disease

- Hypertrophic or dilated Cardiomyopathy / arrhythmia can arise from IMDs. e.g long chain fatty acid oxidation defects,mitochondrial disease, Pompe disease (GSD ll) may present with hypertrophic cardiomyopathy and hypotonia.

First line investigations:

Discuss the specific tests with the lab before obtaining the samples.

- FBC and differential
- Blood gases and electrolytes including chhloride
- Glucose
- Plasma lactate
- Ammonia
- Liver function tests
- Plasma and urine amino acids
- Urine organic acids
- Urinalysis

Rationale

FBC and differential- neutropenia in organic acidaemias, glycogen storage, resp chain disorders
Blood gases and electrolytes- Primary lactic acidosis and organic acidaemias present with an increased anion gap; A mild respiratory alkalosis is present in early stages in hyperammonaemia
Glucose- Hypoglycaemia is a frequent finding in IMD.
Plasma lactate- High plasma lactate may be due to poor circulation, hypoxia or an artifact secondary to sampling errors. Several IMDs are associated with lactic acidoisis.
Ammonia- It is important to measure ammonia in all sick neonates with any non-specific signs of encephalopathy. Urea cycle defects and organic acidaemias are treatable cuses of hyperammonaemia.The free flowing blood sample should be sent to the lab on ice in the appropriate container and analysed within minutes (max 15 min) to be reliable.
Liver Function Tests- – Liver dysfunction may be one of the early features of IMDs.
Urine - ketones (dipstix) may add to the information gained from other tests

Second line investigations:

Carnitine and acylcarnitine profile- for identification of diagnostic metabolites
Urine organic acids and organic acids – Diagnosis or exclusion of IMDs
In some cases, **plasma amino acids and urine – orotic acid may be required.** This will be advised by the IMD team.
Further tests may be required and will be suggested by the IMD consultant.
CSF amino acids- Only required in specific circumstances as advised by the IMD team.
CSF glucose and paired plasma glucose- Only required in specific circumstances as advised by the IMD team.
Peroxisomal function tests- Only in specific circumstances.

MANAGEMENT

Management of the acute disorders is greatly aided when the diagnosis is known, as specific therapeutic measures are available for a number of these disorders. Unfortunately, this is not always possible. So, management while awaiting results is as follows:
1- Stop intake and endogenous production of toxic metabolites. Therefore, temporarily stop feeds.
2- Eliminate protein and fat and administer high calorie high carbohydrate fluids 10% dextrose w saline, and KCL when urine output established.
3- Correct acidosis iv Na HCO3 if plasma bicarbonate <10 mmol/l.
4- Treat any intercurrent illness.
5- Contact the IMD consultant on call immediately. Urgent transfer to the PICU at BCH may be for further management may be required in severe cases.
6- **Follow the up-to-date treatment guidelines for IMDs at http://www.bimdg.org.uk**
7- Intractable seizures may require treatment with Pyridoxal Phosphate 30mg/kg/day in 3 divided doses by NG tube under CFM or EEG monitoring if possible. Please be aware of the risk of apnoea during administration. Please discuss with the IMD team before considering/admistering Pyridoxal Phosphate.

MANAGEMENT OF CHILD WITH FAMILY HISTORY OF SERIOUS ACUTE METABOLIC DISORDER

1-Arrange delivery on Monday whenever possible.

2- First line investigations as above every 24 hours.

3-The plan for treatment at birth should be discussed with and documented early in the pregnancy. The neonatal, obstetric and IMD teams should work closely to ensure the best outcome.

4- It is difficult to outline a generic neonatal management plan as it needs to be tailored to the individual IMD and the patient. The IMD team will advice regarding the treatment plan and should be informed well in advance.

Samples to obtain from a dying child with suspected IMD (Please D/W metabolic team at BCH)

1-**Urine**
10 ml in plain bottle for biochemistry stored at-20^{o}C
10 ml in virology culture medium stored at 4^{o}C.
2- **Blood**
5 ml heparinised sample for biochemistry-Separate plasma as soon as possible and store at -20^{o}C
Store packed red cells at 4^{o}C
5 ml heparinised blood (whole) for chromosomes stored at 4^{o}C
5 ml clotted blood for virology stored at 4^{o}C
5 - 10 ml whole blood for DNA analysis stored at -20^{o}C

3- **CSF**

Take and keep as much CSF as possible, and not less than 1ml
2 ml frozen immediately and stored at -20^{o}C
2 ml into virology culture medium, stored at 4^{o}C

4- **Tissue sample**

Discuss with the labs before taking biopsies. Be clear whether you want fibroblast culture, histology, electron microscopy or virological culture. Each request on the same tissue will have to be handled differently.
Other tissue such as muscle/bile may be required and will be advised by the IMD team

See Appendix for further information.

Appendix:
DETAILS OF THE REGIONAL LABORATORY, & THE TESTS AVAILABLE
Regional Service for The Diagnosis Of Inherited Metabolic Disorders
Department of Clinical Chemistry
Birmingham Children's Hospital

Head of Department:	Professor Anne Green	(0121 333 9922)
Metabolic Laboratory:	Mrs Mary Anne Preece	(0121 333 9942)
Cell Culture/Enzymology Laboratory:	Dr. George Gray	(0121 333 9999)

The following tests are performed by the Metabolic Laboratory.

When requesting any of these investigations, please tell the lab:

- Clinical aspects of the case, including relevant details of family history and degree of urgency of the investigations.
- Current information on feeding regimes and relationship to the onset of clinical symptoms and the samples available.
- Details of all drug therapy. This is particularly important for amino acid and organic acid investigations as many drugs, especially antibiotics and anticonvulsants, interfere.

TESTS	**MINIMUM SAMPLE**	**STORAGE/TRANSPORT**	**COMMENTS**
Urine Amino Acids	2 ml random urine	Store at -20^{o}C. Send to BHH lab to be sent on to BCH.	Dilute samples with creatinine <0.6 mmol/l are unsuitable for analysis.
Plasma Qualitative Amino Acids	0.5 ml blood heparinised	Store plasma at -20^{o}C. Send to BHH lab.	If **URGENT** please notify laboratory as despatched.
Plasma Quantitative Amino Acids	1 ml blood heparinised	Separate plasma ASAP. Store at -20^{o}C. Send to BHH lab deep frozen.	Normally done only if qualitative Amino Acids are abnormal.
Plasma Phenylalanine	1 ml blood heparinised	As for quantitative amino acids.	For dietary monitoring.
Plasma Homocystine	1 ml blood heparinised	Discuss with lab prior to taking sample	For monitoring or patients with homcystinuria.
Urine and faecal sugars.	3 ml fresh random urine or faecal sample	Store at -20^{o}C and transport frozen.	Only samples with positive reducing substances will be analysed.
Erythrocyte Galactose-1-Phosphate Uridyltransferase screening	0.4ml blood heparinised		If **URGENT** please notify laboratory first.
Erythrocyte Galactose-1-Phosphate Uridyltransferase quantitation	2 ml blood heparinised		Done only after a positive screening test.
Blood Pyruvate	5 ml blood heparinised		Laboratory staff must know sample is being taken. Ring for details.
Blood Lactate	0.5 ml blood in EDTA/fluoride		Laboratory staff must know sample is being taken. Ring for details.

Succinyl Acetone Screen	4 ml random urine	Store at -20oC. Transport deep frozen. Do NOT allow to thaw once frozen.	For investigation of tyrosinaemia.
Urine (GAGs) Glycosaminoglycans: Mucopolysaccharides (Quantitation and electrophoresis)	24 hour urine sample	Store at -20oC. Transport an aliquot (approx. 20 ml) deep frozen. Please record total urine volume.	Exceptionally, when a 24 hour urine is not possible, collect a fresh random sample after d/w lab.
Urine oligosaccharides	2 ml random urine	Store at -20oC and transport deep frozen.	This test will auto- matically be done on all requests for GAGs.
Urine Organic Acids	3 ml random urine	Store at -20oC. Transport deep frozen.	Clinical details and information on drug therapy is essential.
Orotic Acid Screen	2 ml random urine	Store at -20oC. Transport deep frozen.	If URGENT please notify lab when despatching.

The following tests are performed by the Cell Culture/Enzymology Laboratory. For all these tests prior arrangement with the Laboratory is **ESSENTIAL.**

Please tell the laboratory if the patient has received a blood transfusion.

TESTS	**MINIMUM SAMPLE SIZE**	**STORAGE / TRANSPORT**	**COMMENTS**
RBC Glucose-6-Phosphate dehydrogenase (G6PD) quantitation	0.5 ml heparinised blood	Transport immediately.	Usually done after a positive screening test. Sample baby & both parents Give baby's sex.
Leukocyte enzymes: Beta-Galactosidase (GM1 Gangliosidosis) Arysulphatase A (Metachromatic Leukodystrophy) Alpha-N-acetylhexosaminidase (Tay Sach's and Sandhoff's).	Please discuss with lab	Transport at +4^{o}C immediately to the laboratory	Full clinical details required before accepting these requests.
I-Cell test	0.5 ml heparinised	Transport whole blood	As above.

(Mucolipidoses II & III)	blood	immediately at 4°C.	
Culturing of fibroblasts	Skin biopsy		Please discuss with lab - see protocol.
Propionate Incorporation Assay (Proprionic acidaemia and Methylmalonic acidaemia)	Skin Biopsy/Cultured Amniotic Fluid Cells		Please discuss with laboratory.
Ornithine oxidation (Hyperornithinaemia)	10 ml heparinised blood	Transport immediately.	Please discuss with laboratory.
Fatty Acid Oxidation Tests (Fatty Acid Oxidation Defects)	Skin Biopsy or 5 ml heparinised blood	Transport immediately.	Please discuss with laboratory.
Citrulline Incorporation. (Argininosuccinic aciduria and Citrullinaemia)	Skin Biopsy		Please discuss with laboratory.

GUIDE FOR THE EMERGENCY INVESTIGATION FOR METABOLIC DISEASE

If a neonate or child presents acutely with a disease thought to be metabolic in origin and is deteriorating rapidly collect the following samples for investigation. Contact the Clinical Chemistry Department (Inherited Metabolic Diseases - IMD) at Birmingham Children's (BCH) via BCH switchboard or on 07919 537125. The guide below is an edited version from the BCH handbook "Laboratory Services for Inherited Metabolic Disorders 2004".

It is essential that specimens are taken whilst the child is suffering from the toxic effects of feeding or else the diagnosis may be missed.

Samples taken within 2 hours of death may be valuable for diagnostic purposes. If samples are taken post-mortem it is extremely important to record the time. Written parental consent must be obtained.

1) **URINE**: Ideally at least 5 -10 ml of random urine. Collect into a bottle with no preservative and store at -20°C. If contaminated with blood, centrifuge to remove cells before freezing.

2) **BLOOD**: Collect 5 – 10 mls in lithium heparin and 0.5ml in fluoride oxalate, separate plasma as soon as possible and store plasma at -20°C. Store the packed red cells at 4°C (do not freeze). If DNA analysis is likely, store a further 5 – 10 ml of EDTA blood in a plastic tube at +4°C

3) **SKIN**: (for fibroblast culture) After thorough swabbing of skin with a sterilising swab and with total sterile technique, take a punch skin biopsy. Place it in suitable transport medium (obtainable from virology or cytogenetics – use saline in an emergency). As soon as possible inform the Cell Culture laboratory at BCH. The specimen should be stored at 4°C prior to sending. **Sterility is of paramount importance when taking skin biopsies, especially post-mortem samples.**

4) **TISSUE SAMPLES**: (e.g. liver, heart muscle, skeletal muscle)

   Tissue samples are useful for biochemical analysis only if taken within 2 hours of death. These should only be taken if there is a strong clinical suspicion of a primary defect in one of these tissues: blood and urine should also be obtained.

- Obtain the liquid nitrogen from the lab first.
- Label to show the type of tissue and patient ID before taking the biopsy.

- 2 or 3 needle biopsies of tissue should be taken, put in a small plastic tube, immediately capped or sealed with plastic to prevent the biopsy drying. Then snap freeze in liquid nitrogen (or solid CO_2). Store the sample deep frozen, as cold as possible. Talk to the BCH lab before transporting in liquid nitrogen.

5) **CEREBROSPINAL FLUID**:
Collect a 1 ml sample and store deep frozen.
Centrifuge and separate the supernatant if blood stained.

CONTENTS OF THE METABOLIC EQUIPMENT PACK

Mainly for use in a terminally ill baby to ensure sample collection

Syringes: 2 x 20 ml (bladder aspiration) 1 x 2 ml (CSF)

Liver biopsy needle (true-cut 17 gauge biopsy/aspiration needle
for liver, brain, muscle & kidney

Specimen bottles:-
Heparin 1 x 5 ml
2 x 10 ml
Plain 5 x 5 ml (for CSF and serum samples)
Plain metal x 5 (for snap frozen specimens)
Formalin x 5
* Culture medium for skin, fibroblasts x 2 (keep in fridge)
Virology culture medium x 7 (keep in fridge at 4^oC)

Skin biopsy instruments (Sterile)

Punch biopsy syringe (strongly preferred)
Scalpel Scissors
Tooth forceps Silk suture

Aluminium foil
Request cards

* This probably should be replaced every 6 months. Sterile saline may be used instead in an emergency.

Glutaraldehyde for EM needs to be freshly prepared and so it will probably only be available during office hours.

Tissue samples: Discuss with the labs before taking biopsies. Be clear whether you want fibroblast culture, histology, electron microscopy or virological culture. Each request on the same tissue will have to be handled differently.

Skin

Skin is required for fibroblast culture, for electron microscopy and for virology.
The cultured fibroblasts are used for enzyme and chromosome analysis.

The sample should be taken using full aseptic technique after thorough skin cleansing using a sterilising swab.

The specimen may need to be divided into 4 as follows:-

Fibroblast culture medium stored at 4^oC. **Do not freeze.**
Formalin for histology stored at room temperature
Glutaraldehyde for E.M. stored at 4^oC
Virology culture medium stored at 4^oC

Other tissue samples

Liver, brain, kidney, heart or skeletal muscle should be taken and stored if there is a strong clinical indication of a primary defect affecting one of these organs. Several needle biopsies should be taken from the affected organs as soon as possible after death and always within 2 hours.

Specimens of each tissue taken should be treated in the following way:-

Place 2 or 3 needle biopsy specimens in envelopes of aluminium foil and snap freeze in liquid nitrogen for biochemical analysis

One specimen in formalin for routine histology

One specimen in glutaraldehyde for E.M. stored at $4^{o}C$

One specimen in virology culture medium stored at $4^{o}C$

The specimens should be transported to the relevant departments with the appropriate request forms, i.e. clinical chemistry, cytogenetics, virology, histology. During working hours clinical chemistry and cytogenetics in particular should be informed before the specimens are dispatched.

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9- British National Formulary for Children

VG June 2010

Hyperkalemia

Introduction

Normal range of K+ in infants is 3.5-5.5mmol/L. Mild/moderate hyperkalaemia in infants is not uncommon in the neonatal period. 30% of infants less 28 weeks develop a serum potassium above 7mmol/L during the first days of life. When potassium concentrations are raised, the underlying causes must always be considered, together with the degree of illness in the infant.

Causes

- Sampling
- Non-oliguric hyperkalaemia of the preterm infant
- Renal failure/oliguria
- Acidosis
- Others- Medication/prescription errors, CAH, Bruising/Haemolysis

Management

Confirmation of hyperkalaemia with repeat sample

K+ 5.5 - 7.0 mmol/l

- Stop all K+ containing infusions
- Recheck 12 hourly until not rising
- Calcium gluconate (10%) 0.5 ml/kg as a slow infusion over 5-10 min. if ECG changes

K+ > 7.0 mmol/l (Always discuss with consultant on call)

- As above
- Correct acidosis with sodium bicarbonate 4.2% (dilute 8.4% with equal volume of 10% dextrose) at 2ml/kg as slow infusion over 30 minutes
- Insulin/Dextrose- start glucose infusion of at least 10mg/kg/min (equivalent to 150ml/kg/day of 10% dextrose). If already on this, increase to 12.5 mg/kg/min (equivalent to changing to 12.5% dextrose). Commence insulin at 0.05 u/kg/ hour. Titrate insulin to maintain blood glucose between 4-10 mmol/L. If blood glucose drops below 4mmol/L whilst on 0.05 u/kg/hour insulin, increase glucose delivery rather than discontinue insulin and recheck blood glucose within 1 hour.
- Salbutamol 4 micrograms/Kg IV over 5-10 minutes. Repeat if necessary.
- Calcium resonium 125-250 mg/kg PR, repeated as necessary every 6-8 hours. (Note: In a trial comparing resonium with insulin, mortality was 80% in resonium group (14% in insulin group). The resin was not particularly effective, and there was a high incidence of intracranial haemorrhage associated. It should therefore be reserved primarily for term infants).

If all else fails

- Consider exchange transfusion for preterm non-renal failure infants
- Consider dialysis for renal failure. Advice should be sought relatively early with renal specialists.

References

1-Mildenberger E, Versmold HT. Pathogenesis and therapy of non-oliguric hyperkalaemia of the premature infant. Eur J Pediatr. 2002 Aug;161(8):415-22.

2-Lui K, Thungappa U, Nair A, John E. Treatment with hypertonic dextrose and insulin in severe hyperkalaemia of immature infants. Acta Paediatr 1992 Mar;81(3):213-6.

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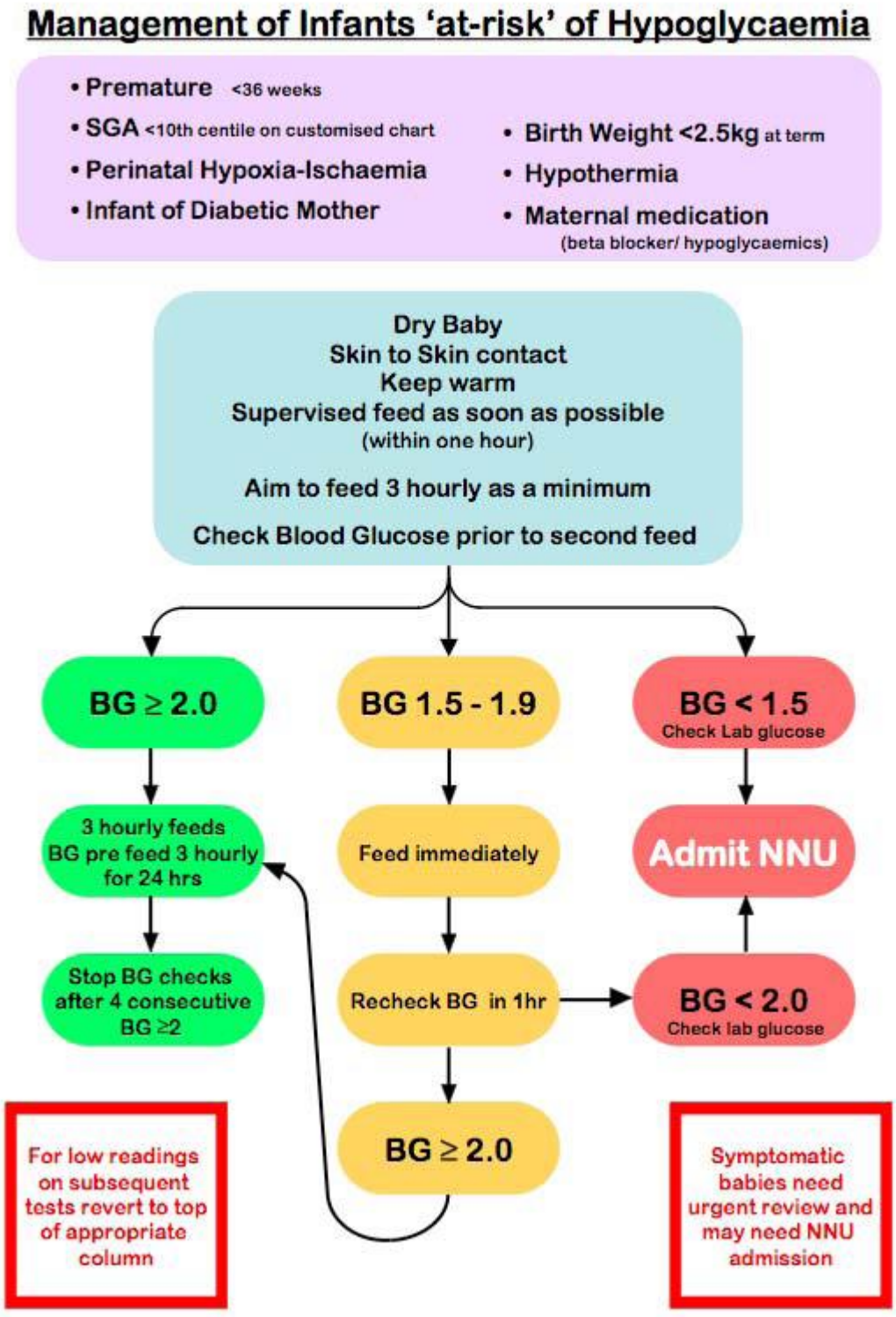
Glucose infusion rate = Concentration of dextrose (%) x Flowrate (mL/kg/day)
(mg/kg/min) 144

VG 2010

Hypoglycaemia

The SWMNN guidelines are to be followed. The following chart summarises the management of babies at risk and with hypoglycaemia.



Screening methods

Glucose screening measurements should be made using a ward-based Glucometer (eg Medisense™) or by a blood gas analyser. These should be calibrated regularly according to manufacturers instructions. Results should be recorded as 'blood glucose' or 'BG' in the notes (not BM).

Who should be screened and when ?

Healthy term infants should not be screened

Healthy full term infants, born following an entirely normal pregnancy and delivery, are not at risk of problems from hypoglycaemia. They may have transiently low blood glucose in the first days of life, but this is not clinically significant. They are able to utilize other fuels to meet their metabolic needs.

Following delivery, these babies should be dried, and then placed 'skin-to-skin' and offered regular breast-feeds in accordance with Baby Friendly and NICE guidelines. Healthy term babies, do not require routine blood glucose monitoring.

However, a baby who is not feeding well despite help, is unexpectedly sleepy or unwell in some other way may require a blood glucose check as part of a thorough evaluation by an ANNP or Paediatrician.

Screen infants with abnormal clinical signs

Babies who suffer symptoms from hypoglycaemia are at the highest risk of suffering an adverse outcome. Therefore if any infant shows clinical signs compatible with a significantly low blood glucose concentration (Table 1) an ANNP or Paediatrician must be called to perform a thorough assessment of the baby which should include a measurement of the blood glucose.

Symptomatic babies will often have an underlying pathology causing the hypoglycaemia, which should be sought. Most babies in this group will require neonatal unit admission for further management.

TABLE 1. Clinical Signs often associated With Hypoglycemia

• Changes in levels of consciousness
Irritability
Lethargy
Stupor
Coma
• Apnea, cyanotic spells
• Feeding poorly, after previously feeding well
• Hypothermia
• Hypotonia, limpness
• Seizures
'Jitteriness' is rarely associated with hypoglycaemia in term infants

For the symptoms to be attributed to hypoglycaemia, a low blood glucose must be documented and the symptoms should be ameliorated with restoration of a more normal blood glucose. As symptomatic babies are at higher risk of complications, different thresholds should be used . Below 2.6mmol/L is considered low in the presence of symptoms and the aim of treatment is to restore glucose to above 3.3mmol/L .

Treatment with an IV bolus of 3ml/kg 10% Dextrose is recommended always followed by an ongoing dextrose infusion. Feeds may continue if the clinical situation allows.

Screen infants with risk factors for compromised metabolic adaptation

Regular measurements of blood glucose concentration should be undertaken in infants known to be at risk of hypoglycaemia. The table below shows conditions, which may put babies at risk of hypoglycaemia.

Table 2. At-Risk of Hypoglycaemia

A. Maternal conditions

• Diabetes during the pregnancy
• Drug treatment (Beta Blockers / Oral hypoglycemic agents)

B. Neonatal conditions

• IUGR/SGA (<10th centile on individualized growth chart & < 2.5 Kg at term)
• Preterm (<36 weeks)
• Hypothermia
• Perinatal hypoxia-ischemia (5 minute Apgar <5)
• Obvious syndromes (e.g. Midline defects, Beckwith-Weidemann syndrome)

Babies in these at risk groups should be identified as soon as possible after birth and measures to prevent hypoglycaemia initiated.

Babies should be dried and kept warm with 'skin-to-skin' and encouraged to breastfeed. They should feed within the first hour after birth and then continue breastfeeding at regular intervals - every 3 - 4 hours as a minimum.

Breastfeeding should be promoted in accordance with Baby friendly guidelines. It is particularly important that mothers of babies who are at risk of hypoglycaemia are actively encouraged to breast-feed, as colostrum and breast milk contain metabolites, which are thought to help babies cope with the physiological drop in blood glucose. If the baby is not able to suck effectively then mothers should be encouraged to express their milk.

Formula milk should not be offered to breast fed babies. If however, after discussion, a mother makes an informed choice to feed her baby formula milk, her decision should be supported.

When should blood glucose be checked in 'at risk' babies?

Blood Glucose should be checked at the following times

- **Before the second feed** (3 – 4 hours of life)
- **Then 3 hourly BEFORE each feed**

As glucose is most likely to be low in the first 24 hours, screening can discontinued after this time, if the baby is feeding well or before if the glucose concentration has been shown to be 2 mmol/L or above on 4 consecutive occasions. Pre-feed checks should continue if concerns persist.

In some areas, particularly the USA, it has become the norm to check glucose in these babies very soon after birth. As the intervention in babies found to be low at this time would be to feed and then reassess later with another blood glucose check, it seems kinder to the babies to concentrate on feeding during this time and check glucose prior to the second feed. This approach, which is advocated by the experts in this field based in the UK, postpones screening to a time when glucose metabolism is in steady state so results should be more meaningful.

The Management of Asymptomatic Hypoglycaemia

Results of the first screening check (before second feed at 3-4 hours of age)

Very low glucose concentrations < 1.5 mmol/L

- These babies need admission to the NNU / SCBU
- A blood sample must be sent to the laboratory for Glucose measurement.
- Treatment with an I.V Dextrose infusion at 4 - 6 mg/kg/min should be considered
- Feeds should be continued if tolerated

Low glucose concentrations 1.5 – 1.9 mmol/L

- These babies should be fed immediately
- The feed should be supervised and the mother given extra help with breastfeeding
- If the baby is not feeding well give EBM, or formula if that is the mother's informed choice
- Blood glucose must be re-checked 1 hour after the feed

Glucose concentration 2.0 and above

- These babies should continue to be fed regularly (3-4 hourly)
- Blood glucose screening checks should be performed before feeds
- Mothers should continue to be supported with breastfeeding or expression of EBM

Some ward-based glucometers are not designed for maximum accuracy in this lower range. Where concerns about this exist, it has been suggested that quickly rechecking a low reading with a new sample from the opposite heel may increase confidence in the results.

Results of subsequent glucose checks

If a baby is found to have 2 consecutive blood glucose results below 2.0mmol/L despite extra feeding support and interventions then admission to NNU / SCBU is indicated. Here more intensive feeding regimes can be considered and/or an IV Dextrose infusion.

Other strategies

Is there a role for 'Hypostop' ?

Although 'Hypostop' has been shown to cause of slight increase in blood glucose when given to newborns, the WHO expert panel found that there was not sufficient evidence to recommend its use in this situation.

Is there a role for 'Preterm' formula ?

Although preterm formula milks may have a higher calorific content than Breastmilk, there is no evidence to support the use of a 'preterm' formula milk in place of breastmilk, during the management of asymptomatic hypoglycaemia.

Full guideline available in the guidelines section of SWMNN website. Follow link below

http://www.newbornnetworks.org.uk/southern/
JMe coauthored this guideline

Guideline for persistent hyperglycaemia

1. Confirm persistent hyperglycaemia >12mmols/l with a true blood glucose.

2. Repeat bedside test within 4 hours. If bedside result still >12mmol/L, perform urinalysis and confirm with another true blood glucose.

3. Calculate glucose infusion as mg/kg/min (see Hypoglycaemia section).

4. If glucose infusion is >10mg/kg/min – reduce to no more than 8-10mg/kg/min and recheck bedside test in 1 hour.

5. If true blood glucose >12mmols/l and glycosuria (3 or 4 +; or >2%) consider insulin infusion.

6. If the levels are very high (> 20) consider that there may be an error in the bags of fluid being administered and change all fluids to new bags/syringes, and flush out the lines with the new solutions.

7. Start soluble insulin infusion at 0.05iu/kg/hr. **Check bedside blood sugar hourly while on insulin infusion, at least until blood sugar stable and reviewed by consultant.**

8. If blood sugar <12mmol/l decrease insulin dose to 0.02iu/kg/hr.

9. If blood sugar <8mmols/l stop insulin.

Revised May 2006 VF and March 2007 MW, JS2010

CARDIOVASCULAR SYSTEM

Patent Ductus Arteriosus

Clinical Features

- Precordial murmur (commonly purely systolic) in the pulmonary area
- Hyperactive precordium
- Bounding pulses
- Resting tachycardia
- Wide pulse pressure
- Cardiomegaly on chest X-ray
- Carbon dioxide retention
- Frequent apnoeas
- Failure to wean off the ventilator at the expected time or unexplained deterioration of respiratory status

Diagnostic features

- Pulmonary plethora or congestion with cardiomegaly on chest radiograph
- Direct visualisation of PDA on two-dimensional Doppler colour-flow echocardiography
- Echocardiography criteria for a significant PDA.

Note;

- From day 4 onwards, physical signs, particularly the murmur, become more accurate but some inaccuracy persists up to day 7 of life[1].
- In a blinded study, the median delay of clinical over echocardiography diagnosis was 2 days[2].

Management of PDA

The National Collaborative Trial has shown no support to surgical treatment over medical so medical treatment is our first line treatment for PDA closure[3].

- **Optimise oxygenation**
- **Restrict fluids** to 100 -120 ml/kg/day
- **Correct anaemia** (maintain haematocrit >40%, Hb > 12g/dl))
- **Give diuretics**, for fluid overload or congestive heart failure.
  - Furosemide 0.5-1 mg/kg/dose once or twice daily (1-3 mg/kg IV for congestive heart failure).
  - For maintenance: chlorothiazide 20 mg/kg with amiloride 0.2 mg/kg once or twice daily.
  - Monitor U & E.

- **Indomethacin** 200 micrograms/kg IV as an initial dose and then 100 micrograms /kg IV over 30 minutes once a day for 5 more days.

  Course may be repeated after 48hrs if necessary.

Note:

1. Prior to the closure of indomethacin, the following should be checked and documented:
   - Detailed clinical examination
   - Cardiac echo (if possible)
   - Renal functions
   - Urine output
   - Platelet count
   - Cranial USS
   - Weight

2. Indomethacin decreases platelet aggregation, gastrointestinal perfusion, and renal blood flow (causing transient reduced GFR and urine output, and a dilutional hyponatraemia, necessitating a 20% reduction in fluids during treatment). However hydration should be good before starting indomethacin in order to avoid renal shut down.
3. 2nd courses may be given to infants who do not respond to 1st course or with recurrent PDA. Non-response to a single course in infants of <1000g birthweight is an indication for surgery[4].
4. After 14-21 days indomethacin efficacy is reduced and it is ineffective in infants aged >6 weeks[5].

Relative Contraindications for Indomethacin Therapy

- Life threatening infection
- Active bleeding – (new or enlarging IVH, rectal bleeding, frank pulmonary haemorrhage or bloody aspirates)
- Severe thrombocytopenia (Plt count <40) or coagulation defects
- Severe unconjugated hyperbilirubinaemia (SBR > exchange transfusion level)
- Renal failure (u/o<1ml/kg/hr or creatinine >120)
- Known or suspected NEC.
- Pulmonary hypertension
- Duct dependent congenital heart diseases.

Indications for Surgical Closure of PDA

- A strong contraindication or side effect to indomethacin therapy,
- Failure to respond to indomethacin therapy

Prior to surgery detailed echocardiography should be performed to exclude associated congenital heart disease with duct-dependant lesions.

References:

1. Davis P, Turner-Gomes S, Cunningham K, Way C, Roberts R, Schmidt B. Precision and accuracy of clinical and radiological signs in premature infants at risk of patent ductus arteriosus. Arch Pediatr Adolesc Med 1995 Oct;149(10): 1136-41.
2. Skelton R, Evans N, Smythe J. A blinded comparison of clinical and echocardiography evaluation of the preterm infant for patent ductus arteriosus. J Paeds Child Health 1994;30:406-11.
3. Gersony WM, Peckham GJ, Ellison RC, Miettinen OS, Nada AS. Effects of indomethacin in premature infant with patent ductus arteriosus: results of a national collaborative trial. J Pediatr 1983;102:895-906.
4. Hafeez U, Watkinson M.When is a second course of Indometacin effective in ventilated preterm neonates with patent ductus arteriosus?
5. Firth J, Pickering D. Timing of indomethacin therapy in persistent ductus. Lancet 1980; July: 144

(Revised UH, April 2006, A Raza, RHM May 2010)

Asymptomatic Heart Murmurs

Heart murmurs are common in neonates and may reflect physiological circulatory changes. However clinical differentiation between innocent murmurs and those associated with structural heart disease is difficult. A 24-hour period of observation is helpful as some of the murmurs may disappear.

If a murmur is still present on a repeat assessment 24 hours later or if it was noted to be sufficiently loud on the first assessment (reviewed by paediatric registrar and felt to be secondary to structural heart disease), the following need to be carried out.

1. Thorough clinical examination including palpation of upper and lower limb pulses along with looking for signs of cardiac failure.

2. Pulse oximetery for oxygen saturation measurements in the right arm and one of the legs. This will provide both pre and post ductal saturations and difference should be $\leq 3\%$.

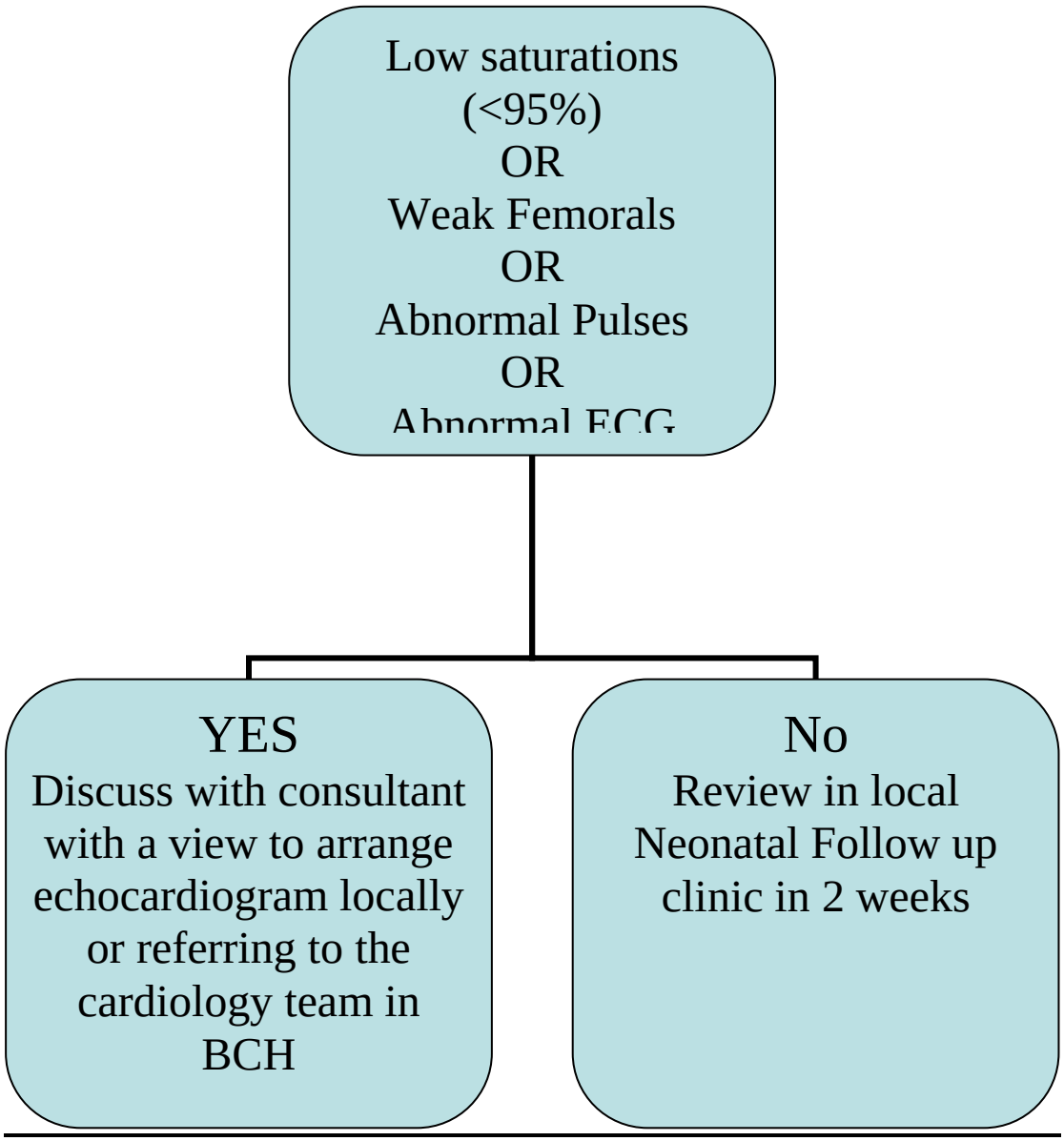
3. Four limbs BPs (although in optimal conditions, right arm plus one lower limb will be sufficient).

4. Consider ECG which should be 12 lead including a V4R lead. Determination of QRS axis is especially important. This is best done using leads 1 and aVF which will help you in determining the QRS axis

quadrant and QRS axis will be closest to the lead having tallest R or S wave in that quadrant.

Subsequent management is as follows:

Asymptomatic Heart Murmur in Neonatal Period



References:

1. Johnson R, Holzer R. Evaluation of asymptomatic heart murmurs. Current Paediatrics 2005; 15, 532-538.
2. Crossland DS, Furness JC, Abu-Harb M et al. Variability of four limb blood pressure in normal neonates. Arch Dis Child Fetal Neonatal Ed 2004; 89(4):F325-7.

Umbilical Catheters (UAC and UVC)

A: Markings on the catheters:
These may vary with manufacturer but usually they are marked every 5 cm. A single mark at 5cm, double mark at 10cm, triple mark at 15 cm etc. the double lumen UVC catheters have the number of centimetres from the tip on them.

B: UAC insertion length:
Insert the UAC the following distance from the plane of the abdominal skin:

(Birthweight in Kg * 3) + 9cm (+ umbilical stump)

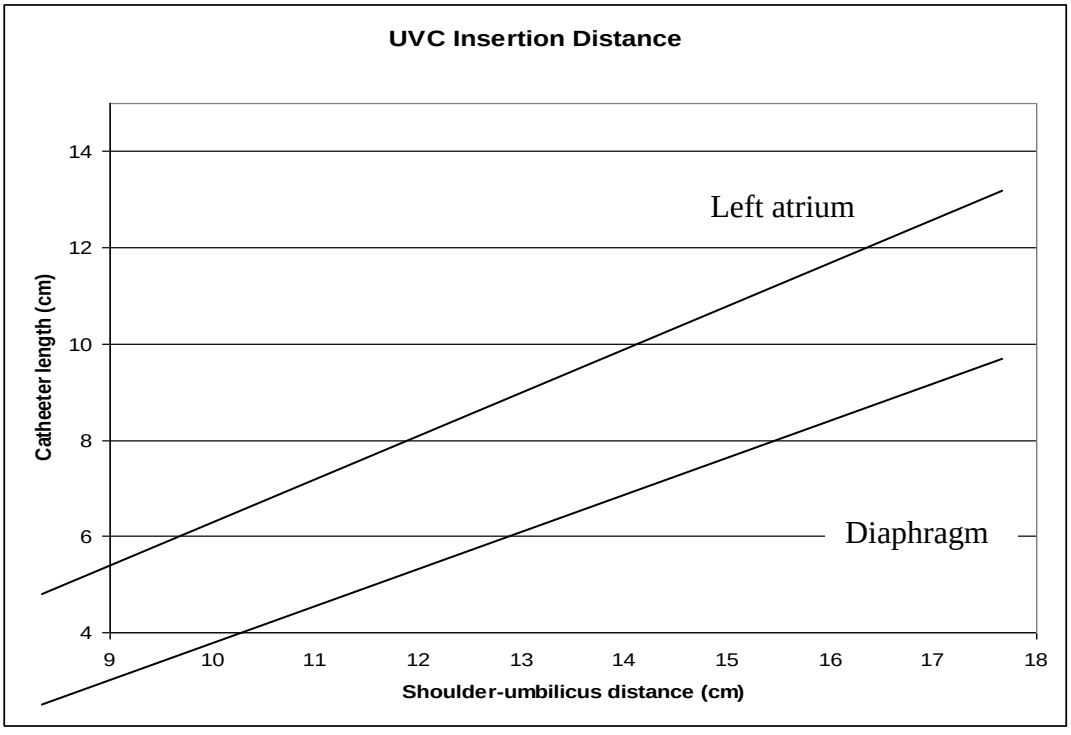
C: UVC insertion length
The chart, based on shows the distance to insert an **umbilical venous** catheterHowever, the venous catheter may go into hepatic veins rather than the inferior vena cava and **the catheter must not be forced in to the expected distance** if resistance is encountered – it may be in the liver. If blood can be drawn back easily, the catheter is probably adequately placed: if not withdraw the catheter a few millimetres and try to withdraw blood again.

An approximation of this is to use the calculation of:

UVC length (cm) = (1.5 x birthweight (kg)) + 5.5

or UVC length (cm) = half the UAC length (as above) + 1cm

In babies < 1000g, use double lumen UVCs: one lumen for sampling and basic infusions, one for TPN. These may also be useful in larger babies, but are inappropriate for exchange transfusions where a single large lumen is best.



MW 1999, revised Oct 2003

Hypotension

Hypotension is a <u>mean</u> systemic blood pressure (mmHg) less than an infant's gestational age in completed weeks.

This applies particularly during the first week of life, but BP tends to rise with post-natal age.

The definition above is that of BAPM: it is the 'rule of thumb' used on the NNU. However, the definition is disputed, and as a further aid to thinking about blood pressure in preterm infants, centile charts for mean blood pressure are shown at the end of this section. We thank Professor Neil McIntosh of Edinburgh for permission to use his data that was published in a different form.

The major concern about hypotension is its association with intraventricular haemorrhage, periventricular leukomalacia and poor neurodevelopmental outcome.

<u>Clinical features of hypotension</u>

- Tachycardia
- Metabolic acidosis
- Impaired renal function (pre-renal failure)
- Decreased pulmonary blood flow (impaired gas exchange)
- Capillary refill time >3 seconds (best sites - the forehead and sternal midpoint)
- Wide core-toe temperature gap (>2°C), but less reliable in the first 3 days of life
- Reduced PI (perfusion index) on the pulse oximeter

<u>Management of hypotension</u>

- **Dopamine** (10 μg/kg/min) and increase to 20 μg/kg/min in 5 μg/kg/min increments. Higher doses may be considered, but <u>must be discussed with a consultant</u>.
  - Dopamine is more effective than dobutamine in the short term treatment of systemic hypotension in preterm infants.
  - Dopamine is more likely than volume expansion to raise blood pressure when given as an empirical first line measure to hypotensive preterm infants.
  - Dopamine and other inotropes may be inactivated if infused with bicarbonate.

- The hypotensive, shocked newborn infant may benefit from **volume expansion** (normal saline, human albumin 4.5%, FFP or blood depending on clinical circumstances) at 10-20 ml/kg over 30 minutes. Volume expansion of > 20 ml/kg in any 24 hours <u>must be discussed with a consultant</u> as there is a risk of pulmonary haemorrhage.

- Replace blood volume with colloid or blood in the hypotensive infant with an obvious recent acute blood loss (e.g. cord accident or feto-maternal haemorrhage)

- Hydrocortisone may be added in VLBW infants:
  2.5 mg/kg IV 6 hrly for 48 hr,
  then 1.25 mg/kg 6 hrly for 48 hr
  then 0.625 mg/kg 6 hrly for 48 hrs.

- For refractory hypotension start an infusion of norepinephrine (50 to 500 nanograms/kg/min) preferably into a central vein at the same time as starting hydrocortisone, as it will give a quicker response in the critically hypotensive baby. The rate of infusion can be slowly increased to 1.5 microg/kg/min, if needed but watch limb perfusion and urine output closely.

- **Epinephrine**: Start at 100 nanograms/kg/min preferably into a central vein and increase up to 300 nanograms/kg/min, if needed. Occasionally doses up to 1.5 microg/kg/min have been used.

- **Dobutamine** (10 – 20 μg/kg/min) increases cardiac contractility and output. It should be considered particularly in asphyxiated term infants where there may be myocardial dysfunction secondary to hypoxia. Giving it to preterm infants already on dopamine infusions has not resolved hypotension

- Asphyxiated infants may respond better to inotropes – both dopamine and dobutamine - than to volume expansion with colloids.

- Seek a paediatric cardiology opinion for infants with severe hypotension to ascertain myocardial function and rule out associated congenital heart disease (by cardiac echocardiography).

Notes

- Keep a running total of the colloid/crystalloid volumes transfused to support the blood pressure and **resist giving more than 20 ml of volume/kg/day**. (Early hypotension in preterm babies is usually ***not*** due to hypovolaemia.)

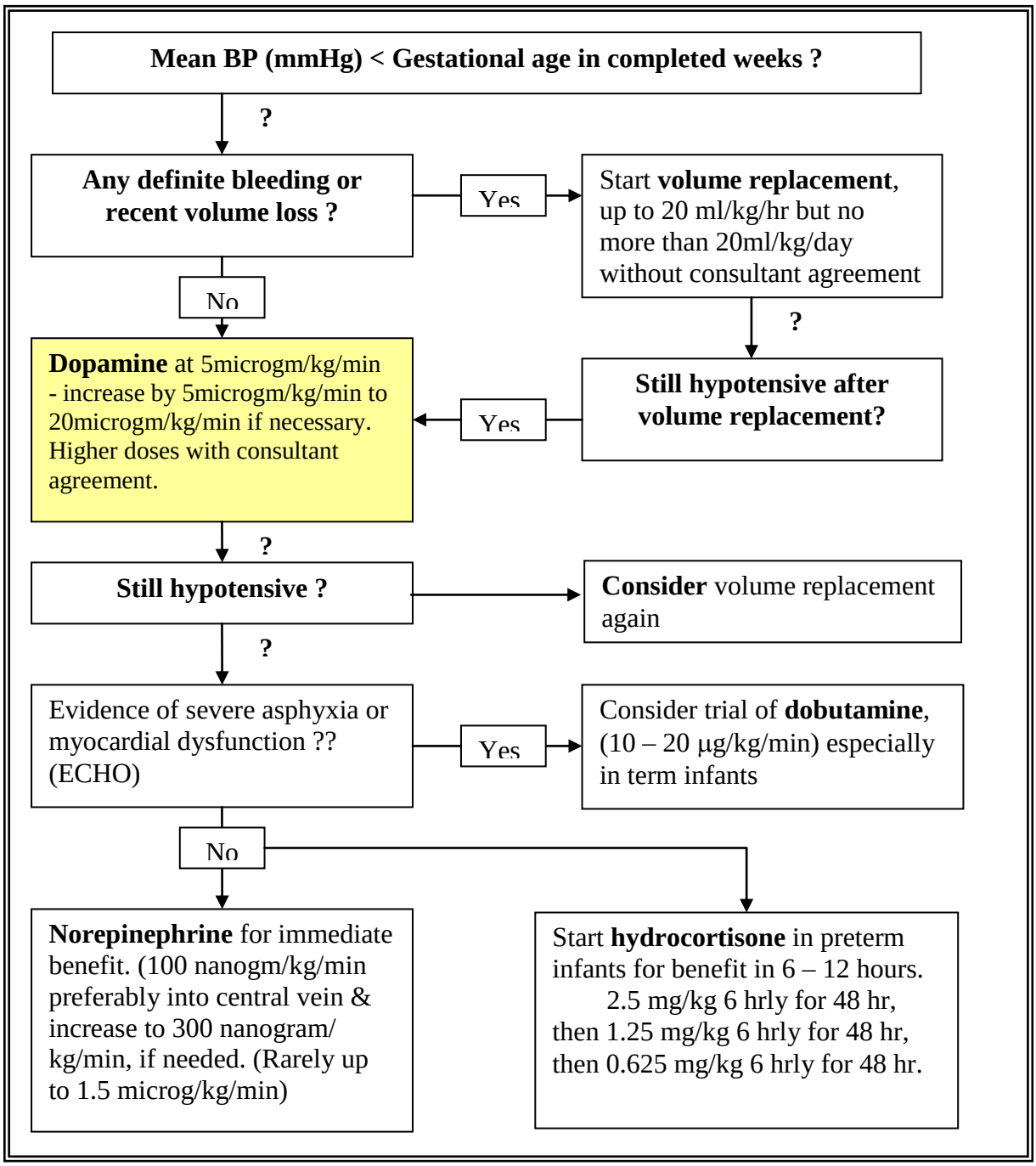
- At high doses the α-adrenergic effects of dopamine produce decreased renal blood flow in adults but not neonates. Decreased pulmonary blood flow (from pulmonary vasoconstriction) can occur, so use with caution if pulmonary hypertension is present. It increases myocardial and cerebral oxygen consumption.

- Dobutamine, with a predominantly β-adrenergic effect, increases left ventricular output and is less likely to increase pulmonary vascular resistance when compared to dopamine.

- Normal saline is as effective as 5% albumin in treating hypotension in preterm infants, at least for the first dose'

- There is no evidence from RCTs to support the routine use of early volume expansion in very preterm infants without CVS compromise. There is insufficient evidence to determine whether infants with CVS compromise benefit from volume expansion. There is insufficient evidence to determine what type of volume expansion should be used in preterm infants (if at all) or for the use of early red cell transfusions. ….. the overall meta-analyses found no … significant clinical benefit in using albumin compared to saline. *(edited from reference)*

HYPOTENSION ALGORITHM



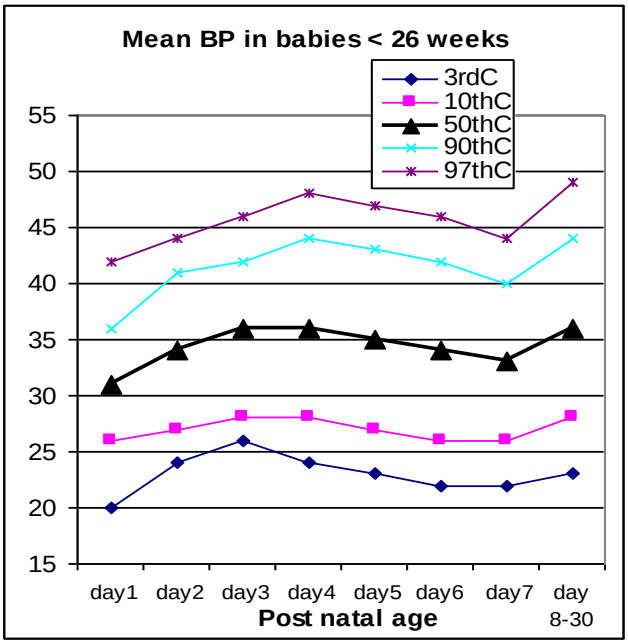
SAR/RHM 2010

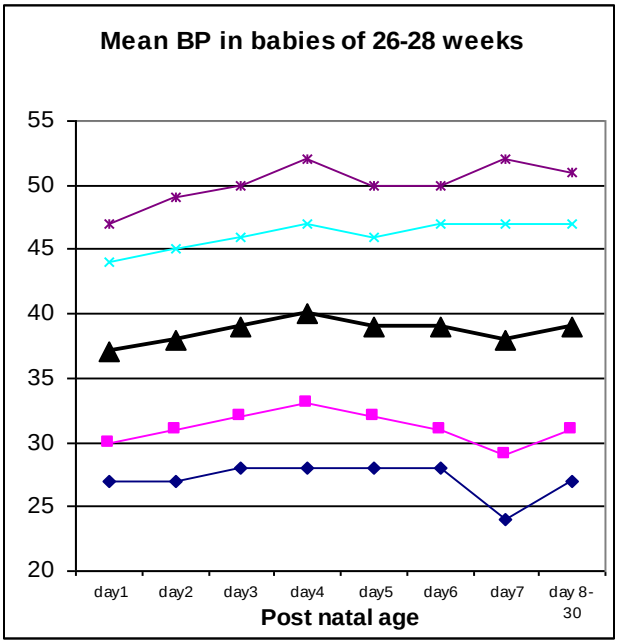
BLOOD PRESSURE CENTILE CHARTS

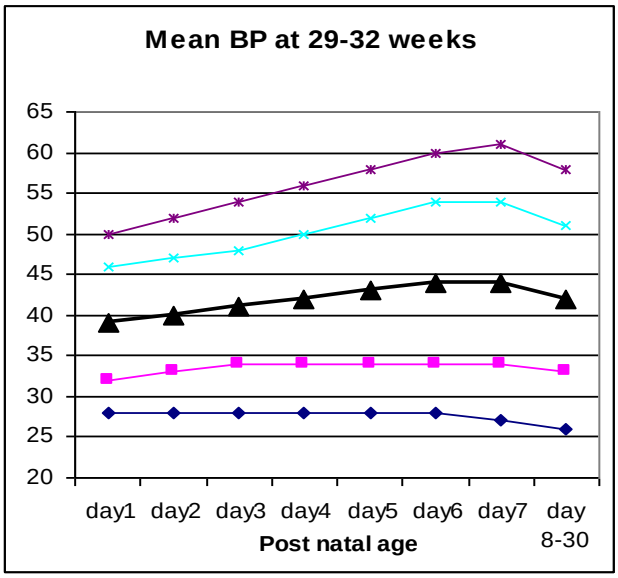
The data for these 5 graphs was based on 722 babies with nearly 90 million blood pressure measurements, taken second by second. The researchers **Error! Bookmark not defined.** describe their subjects as follows:

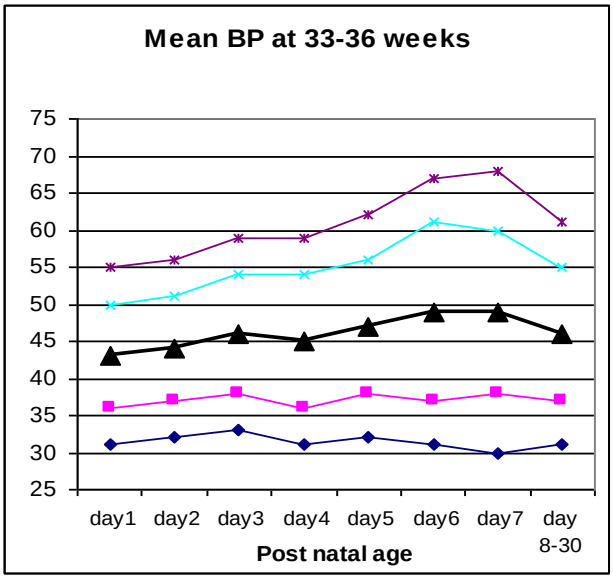
"Babies who required pharmacological cardiovascular support in the way of dopamine, dobutamine or other inotrope were excluded. We also excluded infants who received tolazoline or steroids or who were on medication to prevent IVH. No infants in this study received indomethacin for ductal closure in the 1st week of life, but many of the more immature had ductal murmurs during this time. The other exclusion criteria were development of grade 3 or 4 IVH and PVL whilst on NNU and death before discharge. Many small babies received small volumes of plasma protein substitute (=<10 mls/Kg). This was usually given for perceived poor

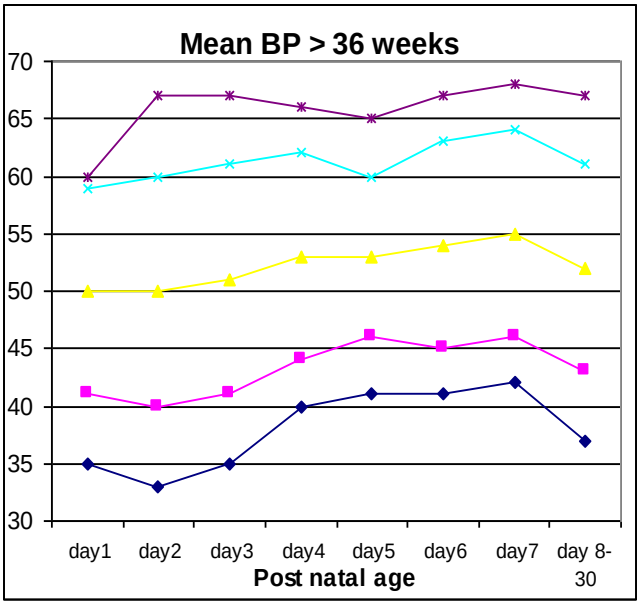
perfusion at birth and prior to intra-arterial monitoring or later for a wide toe-core temperature difference if thermal stress was not believed to be the cause of this."


Mean BP in babies < 26 weeks
3rdC
10thC
50thC
90thC
97thC
55
50
45
40
35
30
25
20
15
day1 day2 day3 day4 day5 day6 day7 day 8-30
Post natal age


Mean BP in babies of 26-28 weeks
55
50
45
40
35
30
25
20
day1 day2 day3 day4 day5 day6 day7 day 8-30
Post natal age


Mean BP at 29-32 weeks
65
60
55
50
45
40
35
30
25
20
day1 day2 day3 day4 day5 day6 day7 day 8-30
Post natal age


Mean BP at 33-36 weeks
75
70
65
60
55
50
45
40
35
30
25
day1 day2 day3 day4 day5 day6 day7 day 8-30
Post natal age


Mean BP > 36 weeks
70
65
60
55
50
45
40
35
30
day1 day2 day3 day4 day5 day6 day7 day 8-30
Post natal age

Hypoplastic left heart

Always discuss promptly with consultant on call
Immediate respiratory management prior to surgery

Ventilation is not mandatory – some 30% will be stable off the ventilator

Indications for intubation and ventilation

- Apnoeas or severe RDS
- Significant metabolic acidosis
- Significant pulmonary over-circulation
- Severe myocardial dysfunction

Ventilate initially with FiO_2 0.21 and PEEP 4 to 5 cm H_2O

Target blood gases: pH 7.35 – 7.40 $PaCO_2$ 4.7-6 kPa, PaO_2 4 – 6 kPa. SaO_2 70 – 85%

- The aim of therapy is to maintain a balance between the pulmonary and systemic circulations. The early sign of pulmonary over-circulation is a rise in arterial oxygen saturation. If left untreated evidence of systemic under-perfusion will emerge with metabolic acidosis, diastolic hypotension, coronary ischaemia and end organ dysfunction. Mild hypoxia should therefore be maintained. Hypercarbia may increase systemic blood pressure.
- Sodium nitroprusside is an intravenous vasodilator that may improve systemic blood flow. It has a short half life and can be titrated to achieve the desired effect.
- Inotropes are not specifically indicated but dobutamine (5 – 10 micrograms/kg/min) can be used in those infants with a severe metabolic acidosis to improve ventricular function.

MW March 2005, RHM/SAR 2010

Surgical guidelines
These are available at SWMNN website and include guidelines for

Inguinal hernia

Gastroschisis

Exomphalos

Oesophageal atresia

To access these guidelines follow the link to SWMNN website and click on guidelines.

http://www.newbornnetworks.org.uk/southern/

Neonatal abstinence syndrome

BACKGROUND

Neonatal Abstinence Syndrome can occur in infants born to mother dependent on certain drugs including opioids, benzodiazepines, alcohol, and barbiturates.

Multiple drugs may be misused by women of childbearing age.

The clinical presentation of neonatal drug withdrawal is variable, depending on the drug(s), timing and amount of the last maternal use, maternal and infant metabolism and excretion and other unidentifiable factors. For example, heroin withdrawal occurs in 50 - 80% of exposed newborns and usually presents within 48 -72 hrs (but can occur up to 7 days).Methadone withdrawal occurs in 60 – 80% of exposed newborns and usually present between 72 – 96 hrs (but can occur up to 4 weeks).

Buprenorphine, an alternative to methadone for treating opioid dependent pregnant women, has shown a slight decrease in the incidence of NAS in a limited number of clinical trials.

The timing of withdrawal onset depends on the time of the last drug exposure and the metabolism and excretion of the drug and its metabolites. The longer the half-life of elimination, the later withdrawal tends to occur. There appears to be little correlation between the amount of maternal drug use and the severity of NAS.

Antenatal care

In our Trust there are clear Guidelines for antenatal care of the pregnant women. The full version of the Guidelines is found by clicking “G”on the Trust’s Intranet Home Page and then going to Obstetric and Gynaecology speciality. An alert form and a pre-birth Plan are generated at 32 -36 weeks gestational age by The Substance Misuse Antenatal Clinic Team. A copy of

the alert form could be found in a dedicated folder in the NNU together with a copy of pre-birth plan.

Postnatal care

General rules

- All mothers and babies should be transferred to the postnatal Ward unless there is a medical reason or a safeguarding issue for admission to SCBU and separation should be avoided whenever possible.
- All babies should receive a course of Hepatitis B vaccine. If mother is Hepatitis Be Antigen positive or has had Hepatitis B infection during pregnancy, baby also needs Hepatitis B Immunoglobulin as soon as possible after birth. Arrangements should be done before discharge to continue their Hepatitis B vaccinations as per Immunization Protocol.
- Supportive treatment (see bellow) is very important.
-
-
-
-
-

Clinical presentation

Gastrointestinal dysfunction:

- Poor feeding, uncoordinated suck
- Vomiting
- Diarrhoea
- Dehydration
- Poor weight gain

Neurological excitability

- Tremors, irritability, high pitched cry
- Hyperactive reflexes(Moro)
- Increased wakefulness
- Frequent yawning and sneezing
- Seizures

Autonomic Signs

- Temperature instability
- Fever
- Mottling
- Nasal congestion

Management on Delivery suite:

- Neonatal ST1/ST2 doctor should be informed when delivery pending but do not need to attend unless there are other indications
- Meticulous hygiene using gloves is vital particularly where mum's serology is unknown.
- It is imperative that **Naloxone (Narcan) is not given** as this is a major risk of respiratory distress and a risk of seizures both of which may be counteracted by use of morphine.(Whittaker 2003)

Management on Postnatal Ward:

- Following the delivery all known drug dependent women should be encouraged to stay in hospital for a minimum of 72 hrs.
- Urine should be collected from babies preferably on the first day of life **in cases where there is not sufficient antenatal information with regard of maternal use of drugs.** The sample should be send to the biochemistry lab writing on the request form: **"for drugs of abuse screening" not for "toxicology**" as we used to write in the past!! If a mother does not agree with the urine test that should be documented in the notes.
- Assessment of babies for withdrawal symptoms using **Finnegan scoring** system (see chart).The scoring system is only a tool to aid the assessment
- Score infants at 6 hrs of age and 4 hourly intervals after that, **approximately 30 minutes post feeding.**
- Score infants for behaviour noted during the four hour period and not just at the time of recordings are made.
- If three consecutive **scores of ≥8** are documented or the average of three consecutive **scores is ≥ 8 the** admission to SCBU has to be considered and treatment should be started.
- Consider other potential causes for symptoms associated with NAS such as hypoglycaemia, hypocalcaemia, hypomagnesaemia, sepsis and meningitis. Consider taking blood for FBC with differential, blood culture, CRP, electrolytes, calcium, magnesium and glucose. If baby remains irritable and inflammatory markers are raised a LP should be consider.
- CUSS and Renal USS should only be considered when there are clinical indications for these.

Management on the NNU

- Nurse with apnoea monitor
- Routine observation
- Scoring to be carried out after feeds, using the Finnegan Chart

Treatment
Supportive

- Swaddling and comforting
- Minimal handling and low light intensity
- Frequent small feeds using a high energy formula if necessary
- Frequent nappy changing as these` babies will have severe nappy rashes.

Pharmacological:
The American Academy of Paediatrics recommends that drug selection should match the type of agent causing withdrawal.
Morphine (Oromorph),

- Studies suggest that morphine is preferable for neonates suffering NAS due to opioid withdrawal. Those receiving oral morphine required a significantly shorter mean duration of treatment versus those treated with Methadone or Phenobarbital (Fischer G et al, 2006)
- Initial dose 40mcg/kg every 4 hrs orally

- Increase dose by 20mcg/kg/dose (up to 100 mcg/kg/dose) until symptoms are controlled
- Continue treatment for 48 hrs
- There is little evidence on how to wean infants from morphine so all decisions are empirical. When scores fall below treatment level (score ≤ 8) for 48 hrs, reduce the dose by 10% per dose every 3 to 4 days, depending on the scores.
- Once on 40 mcg /kg 4 hly the frequency can be reduced especially for babies who will be discharged home on treatment.
- Scoring should be continued 48 hrs after cessation of the treatment
- If after cessation of treatment the score is less than 8 for 48 hrs then scoring may be discontinued
-
- Management of the vomiting baby
-
- Administer the morphine before feed
- Give small feeds frequently
- Ensure that the infant has not been overfed
- Posture the baby appropriately during and after feeding
- If the infant has a large vomit after being given morphine:
- If vomit within 10 minutes of giving the dose, re-dose
- If vomit after 10 min, give ½ of the dose
- If vomits occurs after feed, do not give further morphine

Methadone:

- Can be used for methadone/opioid withdrawal
- Half life is 26 hrs in neonates
- Initial dose is 50 – 100mcg every 6 hrs, then every 12 hrs when signs are controlled
- Final weaning to 50mcg/kg/day before stopping.

Chlorpromazine (with consultant agreement)

- Can be used for narcotic withdrawal symptoms
- Controls CNS and gastrointestinal symptoms
- Dose :0.55mg/kg 6 hly,orally
- Half life 3 days
- Side effects with cerebella dysfunction and decreased seizures threshold limit its usefulness in severely affected babies with fits.

Phenobarbitone and Diazepam are not used for treatment of NAS unless there is a consultant agreement

Breast feeding

The benefits of breast feeding should be discussed with all women antenatally;

The exceptions to promotion of breast feeding are:

- HIV positive women due to high risk of transmission

- If using large quantities of stimulant drugs such cocaine, "crack" or amphetamines because of vasoconstrictor effects
- Careful attention must be paid to recording mother / baby interaction at all times and parental visits, when baby on NNU.

Discharge and follow-up plans

The multi-agency team should be informed that the woman has given birth.

- In most cases where there have been child protection concerns about previous children, social services would have organised a case conference before the baby arrives on the neonatal unit, but the process may not be complete. The case should be managed in the light of the recommendations of the case conference. The case conference minutes may not be available but the **mother's midwife** almost certainly will have been there and there will be a note in the hospital notes.
- If there is an **unbooked pregnancy** and no details are found with regard of maternal history The Community Health Care in the area should be contacted.
- If there are any concerns for the welfare of a baby a Safeguarding " **cause for concern**" referral form should be completed and send off to the named Safeguarding Nurse.
- If mother indicates intention to leave hospital with baby against medical advice and there are "significant concerns" The Duty Social Worker at BCH should be contacted as well as The Police.(see contact details below)
- In the rare situation where mother is only allowed supervised access to the baby in the new-born period prior to fostering, the baby will need to be accommodated on the NNU. Social workers should be informed that the hospital cannot monitor mothers continuously with their babies on the postnatal wards.
- Social workers need to make individual arrangements for management of the situation where the father's access carries restrictions.

Discharge from Postnatal Ward if:

- Social issues addressed
- Discharge Plan in place
- Finnegan scores remain less than 3 over at least 72 hrs.

Discharge form the SCBU

- Social issues addressed
- Discharge Plan in Place

The infants requiring medication for control of NAS symptoms could be discharged into the care of parents/carer if scores remain consistently below 8 and weaning from medication has commenced. (see the discharge list check below)

Follow up arrangements

Babies who received pharmacological treatment and they were admitted to the NNU should be followed up in the NAS baby clinics at Heartlands or Good Hope Hospital according to the area where they live.
First appointment should be arranged for 6 - 8 weeks of age with Dr I Tiron at Heartlands Hospital OPD clinic or Dr Joanne Meran at Good Hope Hospital OPD clinic.
If the babies were discharged home on medication they should receive daily visits from the Neonatal Outreach Team. These babies should have weekly follow up appointments with Dr I Tiron at BHH and Dr J Meran at GHH until the treatment is stopped. Subsequent follow up appointments will be arranged according to the individual circumstances and pathology for a period not less than 2 years.

Discharge checklist for infants discharged on medication

 Respiratory/apnoea monitor has been removed for 48 hrs and no longer required.
 Pharmacotherapy has been deemed effective
 Weaning from medication has commenced

 A case Team meeting has been held with all team members and parents/carer to ensure all aspects of discharge planning have been completed.

 Proposed discharge care of the neonate to parent/carer has been agreed to by the Multidisciplinary Case Management Team

 Visiting Nurse/Community Nurse/Child Health Nurse visits have been arranged while on medication

 GP and Child Health Nurse provided with a copy of the infant's discharge medication dispensing schedule

 The parent/carer has received information on NAS

 The parent/carer has received the information regarding the medication dispensing schedule

 The parent/carer has demonstrated ability to dose the medication.

The parent/carer has demonstrated the ability and the confidence to care for the infant

 The parent/carer has been deemed competent to score NAS

 The patent/carer has agreed to attend scheduled outpatient clinic appointments.

 The parent/carers understands when to seek medical assistance for the infant

 The parent/carers has been provided with mother-crafting education on techniques such as swaddling, settling ,massage, relaxation bath and dummies pacifiers

 The parent/carers has attended infant resuscitation education

Contact numbers for Child Protection referral to Social Services

Birmingham area:	**0121 303 6541**
	Fax: 0121 675 1113
Solihull area :	**0121788 4300**
	Fax: 0121 788 4394
Staffordshire area (GHH babies)	
First response Team :	**0800 1313126**
	Fax: 0178 585 42
Social Service BCH:	**0121 333 8900**
	Fax: 0121 333 8904
HEFT Safeguarding Midwife	**07976255169**

Named Safeguarding midwife	**O7977463311**
Named Safeguarding Nurse:	**extension 49235**
Domestic Abuse Specialist Midwife BHH,	**extension: 42117**
Teenage Pregnancy Midwife based BHH	**extension: 40356**
Specialist Midwife for Substance Misuse BHH:	**extension:40356**
Specialist Midwife for Substance Misuse GHH:	**extension:49344**

Addiction Behaviour Centres (ABC)

Name and address of Community Drug Team	Telephone	Areas covered
Azaadi **604a,Bromford Lane** **Ward End,B8 2DP**	**778 1880**	**East Birmingham**
Mother and Baby Team **The Terrace** **Handsworth**	**301 1600**	**Birmingham**
Mary Street **213 Mary Street** **Balsall Heath** **B12 9RN**	**440 4444**	**South and Central Birmingham**
Slade Road, **411 Slade Road, Birmingham** **B23 7LA**	**685 6400**	**North Birmingham** **Sutton, Erdington** **Kingsbury**

Drug Line Carrs Lane Church Birmingham	**632 6363**	**City Wide Service**
Dalton Place Clinic Dalton Place Hobs Moat, Solihull	**742 3636**	**Solihull**
The Bridge	**678 4900**	**Solihull**
Swanswell	**233 7439**	**Birmingham**

References:

1) American Academy of Paediatrics Committee on Drugs (2001)
2) K Jhonson,C Gerada and AGreenough.Treatment of neonatal abstinence syndrome Archives of Disease in Childhood Foetal and Neonatal Edition 2033;88:F2 – F5
3) Guidelines for the management of the infant with neonatal abstinence syndrome Western Australian Centre for Evidence Based Nursing and Midwifery, January 2007
4) Management of neonatal abstinence syndrome in neonates born to opioid maintained women Drug and Alcohol Dependence Volume 87, issues 2 – 3, March 2007
5) Can Methadone concentrations predict the severity of withdrawal in infants at risk of neonatal abstinence syndrome? Archives of Disease in Childhood Foetal and Neonatal Edition 2004;89:F390 – F393
6) Effects of breast milk on severity and outcome of neonatal abstinence syndrome among infants of drug-dependent mothers. Paediatrics 117(6):E1163 –E1169
7) Women, Pregnancy and Substance misuse - Good practice Guidelines Highland, Scotland
8) Management of neonatal abstinence: a national survey and review of practice .Arch.Dis.Child Fetal Neonatal Edition 2009;94;F249 – F52.

Name: ……... PID: …… Date of Birth: ……

GUIDELINES FOR USE:

1. Score infant at six hours of age and four hourly intervals after that.
2. Score baby for behaviour noted during the six hour period and not just at the time recordings are made.
3. **If two consecutive total scores of five are made, or one of six, then treatment must be considered.**
4. Do not elicit it deliberately. Record only if seen spontaneously.

		Date													
TREMOR	**SCORE**	Time													
Mild tremors disturbed	1														
Moderate/severe tremors disturbed	2														
Mild tremors undisturbed	1														
Moderate/severe tremors undisturbed	4														
Hyperactive Moro reflex	2														
Marked hyperactive Moro reflex	3														

IRRITABILITY															
High pitched cry	2														
Continuous/excessive high pitched cry	3														
Hypertonicity	2														
Myoclonic jerks	3														
Generalised convulsions	5														
Frequent yawning	1														
Sleeps <1 hour after feeding	3														
Sleeps <2 hours after feeding	2														
Sleeps <3 hours after feeding	1														

RESPIRATORY / VASOMOTOR															
Nasal stuffiness	1														
Sneezing	1														
Nasal flaring	2														
Respiratory rate >60/min	1														
Respiratory rate >50/min with recession	2														
Temperature 37.2^{o}C-38.2^{o}C Temperature 38.2^{o}C	1 2														

GASTRIC DISTURBANCES															
Frantic sucking of fists	1														
Poor feeding	2														
Unprovoked possetting	2														
Projectile vomiting	3														
Loose stools	2														
Watery stools	3														
		TOTAL													

Based on Finnegan et al 1975 ,

Erbs /brachial plexus palsy

These babies must be refer to Miss Lester at BCH immediately after birth.
The **referral form** for Neonates with paralysis of the upper limb(**suspected obstetric brachial plexus palsy**) can be found in the Neonatal Secretary Office at BHH and GHH. **Fax: 0121 333 8131 or e mail the form to samantha.harding@bch.nhs.uk** All instructions could be found on the referral form.

They often resolve spontaneously, but **must** be seen by a paediatric physiotherapist within 48 hours of birth (so refer promptly) and also refer to Miss Lester at BCH immediately after birth.

The aims of physiotherapy are:

1) to keep the joints mobile and prevent contractures while the nerves recover and
2) to advise the carers on preventing damage to the joint.

Do not discharge prior to physiotherapy assessment.

Birmingham Children's Hospital NHS
NHS Foundation Trust

The Birmingham Childrens Hand and Upper Limb Service

Diana, Princess of Wales
Children's Hospital
Steelhouse Lane
Birmingham
B4 6NH

Tel: 0121 333 9999
Fax: 0121 333 9998

Neonatal Referral Pathway for *OBSTETRIC BRACHIAL PLEXUS PALSY*

Background

OBP Palsy is a rare complex condition, which can lead to severe upper limb dysfunction.
We wish to offer a ***Neonatal Assessment*** and a non-invasive ***Ultrasound examination*** in order to identify babies who may benefit from very early surgical intervention in order to reduce the severity of any future permanent limb dysfunction.

Referral to Birmingham Childrens Hospital

Please fill in the attached form immediately on recognition of **any newborn baby with weakness or paralysis of the upper limb.**

Point of Contact:
Fax: 0121 333 8131
Phone: 0121 333 8136
Email: mailto:Samantha.Harding@bch.nhs.uk

Process

The family will be telephoned and an appointment made within ***1 week*** for an outpatient consultant assessment including an ultrasound examination of the neck and shoulder of the baby.
Access to physiotherapy will be arranged
A further assessment 1 month later will be offered and imaging by MRI scan and EMG studies will be offered if considered appropriate.

Fractures

DO NOT call the on-call orthopaedic team

First line analgesia is paracetamol as in the paediatric drug guidelines.

SKULL Rarely fractures may be found 'under' a cephalhaematoma. If suspected, discuss with registrar/consultant. X-ray. Consider ultrasound and CT scanning.

HUMERUS May be fractured during a difficult extraction. Very painful. Pseudopalsy. Crepitus can be elicited. X-ray. Discuss. Net-elast vest to splint arm to chest wall. Check vascular and nerve supply to forearm and hand. Consultant follow up in 6 to 8 weeks if fracture uncomplicated.

CLAVICLE May be fractured during delivery. Often not diagnosed until callus palpable, although baby may be irritable initially. X-rays often difficult to get a good view because of curvature of clavicle, and diagnosis is more clinical than radiological. Usually no treatment needed. Discuss. Follow up in 6 to 8 weeks.

RIBS Fractures may occur spontaneously/during physiotherapy in babies with osteopaenia of prematurity. Diagnosis usually retrospective when callus appears on CXR. Follow up in 6 to 8 weeks.

FEMUR Fractures may occur during breech extraction. Very painful. Crepitus. Watch for excessive bleeding and swollen thigh. May need NNU admission for observation and analgesia. Healing and remodelling will occur without

Gallows traction. Give analgesia. Support limb gently during handling and nappy changes. Consultant follow-up.

Genetic referrals

The Clinical Geneticists for Birmingham Heartlands Hospital are

Dr Carole McKeown,

- **Dr Louise Brueton,**
- **Dr Sarah Bowdin**

All of them are based in Clinical Genetics at Birmingham Women's Hospital.

Dr McKeown holds clinics fortnightly on Wednesday mornings (1st and 3rd). Dr Brueton's clinics are held in CDC once a month (usually on the second Tues) and Dr Bowdin's are once a month (dates not yet finalised). They can come to the wards on these days to see ward referrals with advance notice.

If you want to discuss or refer a baby / child please contact these consultants on 627 2630. There is also always a duty geneticist available to discuss cases if none of these is available.

Please provide a summary of clinical details and investigations. It is helpful to have someone present who is familiar with the baby.
Clinical Geneticists usually like to record any dysmorphic features in photographs so please obtain parental consent for this prior to the ward visit.

If blood samples are required for genetic tests please send samples in lithium heparin tubes for chromosome tests, and EDTA tubes for DNA tests. See website for further details: www.bwhct.nhs.uk/genetics-index.htm.

If the baby is in extremis please consider taking blood to store DNA, and if parents do not consent to post-mortem, request permission for clinical photos, Xrays, and blood for chromosomes and DNA storage.

Comfort measures prior to painful procedures for non-ventilated infants

Indications

- To prevent and/or minimise pain during and following specified procedures
- To prevent and/or minimise short and long-term effects of painful procedures

These measures must be employed, where safe to do so, prior to all specified procedures.

COMFORT MEASURES

- Swaddling: infants hands should be placed near to its mouth to enable self-comfort. Only the limb being accessed for treatment should be exposed.
- Pacifier
- Cuddling by parent/caregiver
- Sucrose: see prescription below

Following the procedure the caregiver should ensure the infant is settled

SPECIFIED PROCEDURES

1. Cannulation/ Venepuncture
2. Eye Examinations
3. Lumbar Puncture
4. Heel Pricks: Includes Gentamicin/Bilirubin Levels
5. Long Line Insertion
6. Supra-Pubic Aspiration
7. Arterial Stab
8. Immunisations
9. Chest Drain Insertion If Not Ventilated/Sedated
10. Suturing

Instructions for the use of sucrose 24% solution

Ensure sucrose prescribed for use on admission: dose/frequency/time

1] dose: 0.3ml

2] time: 2 minutes prior specified procedure

3] method of administration:
- via syringe on to the tongue, followed by offer of pacifier

- dip pacifier into pot of single patient use sucrose and offer to infant
- draw up single dose in syringe and administer directly in to the infants mouth

Contraindications for the use of sucrose 24% solution

- infants of diabetic mothers until blood sugars stabilised
- infants suspected of or diagnosed with i.e.
- infants with oesophageal atresia/fistula
- infants without bowel sounds

KM 2006

IT 2010

Death, post-mortem and breaking bad news

This is an edited version of the Trust's paediatric version (largely written by Dr Mupanemunda) of its policy on Breaking Bad News. The full version is found by clicking 'P' on the Trust's Intranet Home Page and then going to 'Policies and Procedures'.

The breaking of bad news is conveying a diagnosis of a serious medical disorder, an unfavourable outlook, a deteriorating clinical status, or a terminal illness and/or death. The breaking of bad news can mean something different to different people.
We have a dedicated **Senior Child & Adolescent Psychiatrist** that can help the neonatal staff and also the parents to cope with such difficult times: **Tess Bailey – Sayer tel: 01216836151 and fax:6836153**

Primary Objective
To provide parents with information that is clear and understandable, with sensitivity and empathy**.**

Key Principles

- In all circumstances the breaking of bad news will be between the parent and an appropriately trained professional, with knowledge of the breaking bad news guidelines.
- The discussion will be in a language the parents can understand. An interpreter should be used where necessary.
- The parents' rights to privacy and dignity will be respected at all times.
- Parents will be given contact names and numbers, appropriate to their individual needs.

Breaking Bad News
The manner in which bad news is conveyed can have lasting and far reaching consequences for parents and future parent-professional relationships. When poorly handled, it can lead to a breakdown in trust, mutual respect and impair the parents' ability to cope with the information. This framework is designed to provide a standard for breaking bad news for professionals within the paediatric directorate. It is in addition to other systems and support that are already in place.

Primary / Secondary Interface

In the case of serious and life threatening medical conditions, the consultant should inform the GP of the diagnosis within 24 hours by telephone, fax or e-mail within the principles of the Caldicott Guardian recommendations and the Data Protection Act.

Checklist before Breaking Bad News

- Do the parents have special needs? Identify the implications and ensure that the appropriate support and, where necessary, an interpreter is available**.**

- Gather necessary information **…** 'do I have all the facts?' Try to know all the relevant details and be ready to answer any questions they may have. Check the patient's notes; ensure the correct information is available.

- Ensure appropriate physical setting

Unless absolutely unavoidable the breaking of bad news should be carried out in person and by a suitable person. If by telephone, offer immediate and subsequent support. (see Telephone Protocol for Breaking Bad News on the Intranet). The breaking of bad news will take place in an environment that is calm and friendly. *Summarise information and develop a joint plan with the parents. Where necessary give the parents written information.*

- Encourage the parents to write any questions or concerns they may have for future discussions. Remind the parents of the contact name and number.
- Ensure that parents' concerns and questions are addressed to their satisfaction.
- Document and date the content of the meeting and the main participants' names.

Breaking bad news about a death to parents

Key Principles

In all circumstances the breaking of bad news about a death will be between the parent(s) and an appropriately trained professional who has knowledge of the Breaking Bad News Policy.

- Ideally, the parent(s) will have been prepared for their baby's imminent death; however this may not always be the case.
- Do the parents need an interpreter, if yes, ensure that one is available.
- If the news of the death is to be broken via the telephone follow the Telephone Protocol.
- If the news of death is to be broken face to face, ensure that it is done with empathy and in a sensitive manner.
- The parent(s) will be asked if they wish to have someone with them.
- Escort the parents to a private area (see Privacy Protocol).
- Ensure that there is enough time and space to be with the parents.
- Give the news of the death in a sensitive manner ensuring that the parents feel supported.
- Provide tissues and refreshments as required; allow time for the parents to compose themselves.
- Ask the parents if they wish to see their recently deceased baby.
- Accompany the parents to their baby, or bring the baby to them.
- Stay with the parents, and when appropriate, ask if they wish to be alone with their baby.
- Act in accordance with the parents' wishes.
- When appropriate give information regarding what to do after death.
- Provide the name and number of a person for further contact
- Offer the parents a further opportunity for them or other family members to see the baby.

- Allow as much time as required to ensure that this issue is managed in a comforting sensitive manner

Telephone protocol for the breaking of bad news

These guidelines are set to provide a standard for the breaking of bad news via the telephone. It is always preferable to break bad news in face to face communication rather than over the phone. The breaking of bad news by telephone should only occur if parents have expressly indicated a wish to have bad news communicated to them in this way.

Key Principles

- Consider whether or not, the parents have already been prepared for the possibility of bad news. Has the patient's condition suddenly or unexpectedly deteriorated? Is death imminent?

- Allow enough time to be on the telephone as along as is necessary.

- Gather the necessary information ……. 'do I have all the facts?'

- Be ready to answer any questions parents may have.

- Ask if the parent(s) is alone, if alone, ask if there is someone they can call to be with them following the telephone conversation.

- Communicate the bad news in a sensitive manner ensuring that the parent(s) is given the opportunity to ask questions.

- Answer any questions they may have.

- Offer support during the conversation, ask the parent if they want you to pause at any time to allow them time for understanding and composure.

- Repeat any information as necessary.

- Listen carefully to what is being said and comply with any wishes that the parent may have.

- If the bad news is to alert a parent to a serious deterioration in their child's condition, or death is imminent, the telephone call will of necessity be brief as the priority is to give parents the opportunity to be by their child. The bad news should be accurate, concise, honest and supportive.

- If the bad news is of a death, enquire if the parent(s) wish to see their recently deceased child on the ward.

- Offer further support, for example the name and telephone number of the bereavement counsellor.

- Where necessary ring the parents after an appropriate period to ensure that they are coping with the news.

Breaking bad news well is challenging to the professional and has profound implications for the parents in terms of how they deal with their child's illness and/or bereavement. It can reduce potential psychological morbidity.

Deaths

If not already clinically involved, the consultant on-call must be informed of a death.

The consultant under whom the baby was admitted should be informed the next day whenever possible.

If the care of the baby is changed from intensive to full nursing care, and death is expected:

DO:

- Encourage the parents to cuddle their baby
- Ask if they want other members of the family to be present
- Check if they want a baptism or blessing or other religious ceremony
- Ask if you can take photographs of them with their baby
- Take photos of the baby with some sort of scale visible – a coin, a parent's hand, a ruler
- Warn them that the baby may gasp from time to time, but state that this is a reflex breath and the baby will not be aware of it, nor be distressed by it
- Reassure them that we will ensure the baby does not suffer any discomfort
- Listen to the heart from time to time after the baby has stopped breathing
- Listen to the parents
- Answer their questions as best you can, but tell them a consultant will also offer them an opportunity to talk
- Give them time to be alone with their baby after death
- Suggest a separate meeting later that same day with yourself or a consultant and a midwife counsellor
- Give the nurses time to take handprints etc to go with the baby's 'Bereavement Box"

DO NOT:

- Give a precise time at which the baby will die. (If you are wrong the parents will lose confidence in your judgement)
- Declare the baby dead if you can still hear a very slow heartbeat, even if there is no pulse. (He/she may gasp again!)
- Rush on to death certificates and discussions about post mortem forms unless the parents specifically request this
- Fill out the death certificate until you know the full name for the baby as given on the birth certificate
- Take any post mortem specimens without specific signed consent from the parents

Transportation of Babies for Post-Mortem to the mortuary at Birmingham Women's Hospital

Before sending babies/fetuses to Birmingham Women's Hospital for post mortem the following must be adhered to:

1. A completed Consent Form including signature of parent and witness must accompany the body. An incomplete Consent Form will delay the post-mortem.

2. A completed Request for Fetal/Perinatal post-mortem Form must be completed. Please fill in as many details as possible as lack of information may delay the post -mortem.

3. Photocopies of any scan reports should accompany the body.

4. The placenta must be in a clean, dry leak-proof pot and labelled. This should accompany the body.

5. Patient identification tags with the Mother's name/Baby's name, Mother's and/or Baby's registration number and baby's date of birth must be included. If the fetus is too small to put a tag around the ankle, the tag should be placed around the abdomen, or the tag must accompany the body.

6. Babies for post mortem must be sent/collected during 9.00am - 4.00pm Monday to Friday.

Completion of all of the above stages before the baby is sent for post mortem will ensure that post mortems are carried out promptly and efficiently and the babies are ready for collection as soon as possible.

If the funeral is to take place at the weekend, the on-call person in Histopathology can be contacted via the Birmingham Women's Hospital Switchboard for the release of bodies.

- Please note that all responsibility for the transportation of bodies (both sending to and collecting from Birmingham Women's Hospital) lies with the referring Trust.

MW, August 2006
IT 2010

When an autopsy is declined

It is our practice to offer a full perinatal PM examination to the parents of all babies who die on the NNU, Postnatal Wards or Delivery Suite. This is regardless of whether we are able to certify a cause of death, as there may be useful information to be obtained both for the baby's family and the staff who cared for the infant.

Some parents are unwilling to give their consent – they may feel their baby has suffered enough, or they may not wish to delay the release of the baby for burial or cremation. Sometimes parents find the paperwork required too daunting. If this occurs – it is useful to consider whether there are other tests we could perform which may yield diagnostic information and may be acceptable to the family.

Not all of the following procedures will be appropriate in every situation –but the following categories may be considered.

External examination/photography
If there are concerns about abnormalities or dysmorphism – a careful examination by an experienced clinician may be useful. Any observed findings should be carefully recorded and clinical photography may be invaluable in recording information to allow it to be shared with colleagues. In some situations a Clinical Geneticist may have informed us of their availability to assist with the external examination.

Placental/cord histology
This may show the cause and give an estimate of time of onset of hypoxic/ischaemic insults. Infections may be identified and clues may be obtained suggesting inborn metabolic disease. Fibroblasts can be used for metabolic as well as cytogenetic investigations. It is important to give as much clinical information to the pathologist as possible to guide appropriate testing.

Radiology
X-Rays may be useful when there is suspected dysmorphism or skeletal dsyplasia. They may be able to give an estimate of gestational age (particularly after 24 weeks). In addition they may yield information from body cavities e.g. calcification.
USS of brain or abdomen may confirm or delineate suspected antenatal abnormalities or be useful if dysmorphism noted.
In certain situations it may be useful to pursue the possibility of MRI where it would be the only way to make a positive diagnosis of a recurrent condition.

Blood/urine Tests
Blood may be sent for genetic or metabolic investigations post mortem (cardiac puncture may be necessary if specimens cannot be obtained peripherally). Take lithium heparin (karyotype) and EDTA (DNA) samples for cytogenetics. If metabolic tests are required follow guidelines for emergency investigation of metabolic disease in NNU Guidelines, and in addition take blood spots on a Guthrie card for acylcarnitines.

Urine may be obtained for metabolic tests – a catheter can be used to obtain any urine in the bladder. This can be frozen if there is uncertainty as to which tests should be requested.

Skin biopsy
Post mortem skin samples can be used for fibroblast culture. Cytogenetic and metabolic studies may then be performed. The samples should be placed in viral culture medium (or in an emergency in normal saline and refrigerated – see NNU Guidelines for emergency investigation of metabolic disease). Punch biopsy needles are kept on NNU.
Discussions with parents regarding suggested tests should only go ahead after discussion with a consultant, and should ideally take place with a consultant present. Parental consent is required for any of the above procedures, and should be recorded in the notes.

Discharge planning

Six critical components are included in discharge planning from the NNU:

1. Parental Education.
2. Implementation of Primary Care.
3. Evaluation of Unresolved Medical Problems.
4. Development of the Home Care Plan.
5. Identification and Mobilization of Surveillance and Support Services.
6. Determination and Designation of Follow-up Care.

The three basic criteria that are generally recognized as essential before hospital discharge:

- A sustained pattern of weight gain rather than a specific achieved weight
- Physiologic stability defined as the ability to feed
- Maintaining normal body temperature in an open environment,

Infant Readiness for Hospital Discharge

- A sustained pattern of weight gain of sufficient duration
- Adequate maintenance of body temperature with the infant fully clothed in an open bed with a normal ambient temperature (24°C to 25°C)
- Competent feeding, breast or bottle, without cardio-respiratory compromise
- Physiologically mature and stable cardio-respiratory function of sufficient duration
- Appropriate immunizations administered
- Appropriate metabolic screening performed
- Haematologic status assessed and appropriate therapy given
- Nutritional risks assessed and therapy and diet modified as necessary
- Sensorineural assessments, hearing and fundoscopy completed as indicated
- Unresolved medical problems identified, and plans for treatment clear

Home Care Plan Readiness

There is a dedicated booklet containing an **Integrated Pathway** for **Discharge Planning** that must be completed for every baby by the nurses once the decision was made that the baby can be discharged. The discharge planning starts when the baby is in special care one or two or has reached 34 weeks gestation. **The Discharge Liaison Nurse** should be informed about the potential discharges in the view of completing the Care Pathway Instructions that should be inserted into the case notes.

Family and Home Environmental Readiness

Assessments of the family care giving capabilities, resource requirements, and home physical facilities completed.

- Identification of caregivers and assessment of their ability, availability, and commitment
- Psychosocial assessment for parenting risks
- A home environmental assessment including a home visit by midwife or health visitor
- Review of available financial resources and identification of adequate financial support.

Parents/caregivers have demonstrated the necessary capabilities to provide all care including:

- Feeding, whether breast, bottle, or an alternative technique including formula preparation as required
- Basic infant care including bathing; skin, cord, and genital care; dressing; and comforting
- Infant cardiopulmonary resuscitation and emergency intervention if appropriate
- Assessment of the general early signs and symptoms of illness, as well as the signs and symptoms specific to the infant's condition
- Infant safety precautions including proper infant positioning during sleep and use of car seats
- Specific safety precautions for an artificial airway, feeding tube, ostomy, etc.
- Proper storage, dosage and timing of medications
- Equipment operation, maintenance, and problem-solving for each mechanical support device
- The appropriate technique for special care procedures including care of dressings, stomies or healing wounds, maintenance of an artificial airway, chest physiotherapy, oropharyngeal and tracheal suctioning, and infant stimulation and physiotherapy as indicated.
- Specific modification of home completed as required

Community and Health Care System Readiness

An emergency intervention and a transportation plan have been developed and emergency services providers identified and notified as indicated. (Passport letter as necessary). Follow-up needs have been identified, and appropriate communication exchanged including the following:

- GP identified, and responsibility for care of infant understood

- Surgical specialty and paediatric subspecialty follow-up arrangements made
- Neurodevelopmental follow-up referrals made
- Home nursing visits for assessment and parent support arranged and the home care plan shared with the community team.

The assessment of readiness for home of an infant after neonatal intensive care is complex. Careful balancing of infant safety and well-being with family needs and capabilities is required while giving consideration to the availability and adequacy of community resources and support services.

Cooling

SYSTEMIC COOLING FOR NEUROPROTECTION IN NEONATES ≥36 WEEKS GESTATIONAL AGE WITH HYPOXIC ISCHAEMIC ENCEPHALOPATHY (HIE)

BACKGROUND

Moderate/severe HIE following perinatal asphyxia contributes significantly to neonatal mortality and morbidity including long-term neurodevelopmental sequelae in 25%-60% of survivors.

Evidence from high quality studies including the TOBY trial indicates that "Active Cooling" of neonates at or greater than 36 weeks gestation with suspected **moderate** to **severe** HIE begun within 6 hours of birth and continued in a NICU setting is safe and reduces the risk of severe disability at 18 to 22 months of age.

Therefore, cooling is the first intervention which has been proven in rigorously conducted scientific studies to be beneficial in term & near term neonates with HIE.

ELIGIBILITY CRITERIA FOR COOLING

<u>All of the three</u> criteria must be met.

A. ***Infants ≥36 completed week's gestation with at least one of the following:***

- **Low Apgar scores** ≤5 at 10 minutes after birth
- **Prolonged resuscitation at birth**-endotracheal or mask ventilation/chest compressions at 10 minutes
- **Severe Acidosis** pH < 7.00 from umbilical cord, arterial or capillary blood gas within 60 minutes of birth
- **Abnormal base Deficit** ≥16 mmol/L in umbilical cord or any blood sample (arterial, venous or capillary) within 60 minutes of birth

B. ***Infants ≤6 hours post birth***

C. ***<u>Seizures</u> OR Moderate to severe encephalopathy, consisting of***

- Altered state of consciousness (reduced or absent response to stimulation)
- Abnormal tone(focal or general hypotonia, or flaccid)
- Abnormal primitive reflexes (weak or absent suck or Moro reflex)
- Abnormal aEEG background

EXCLUSION CRITERIA

- ≤35+6 weeks gestation(**There is no published evidence about outcome or complications for infants < 36 weeks)**
- >6hrs of age
- Major congenital abnormalities suggestive of lethal chromosomal anomaly or other syndromes that include brain dysgenesis

Note: Children with anomalies who would normally receive full intensive care (like Down syndrome, cardiac or surgical anomalies) should be considered for HT therapy if asphyxiated and fulfilling the cooling entry criteria and cooling is not seen to contradict the other interventions needed (ref Chakkarapani Acta 2009).

RESUSCITATION SHOULD BE AS PER NLS (UK) PROTOCOL WITH THE FOLLOWING CONSIDERATIONS IN BABIES MEETING CRITERIA A:

- If the infant fulfils criteria **A** by >10 min turn the overhead heater off to avoid hyperthermia. **Allow passive hypothermia to occur by not actively re-warming the child: not having the overhead heater on, drying the baby and not having a hat on the head; turning off the heat in the transport incubator.**
- Request examination of the placenta for signs of infection or abnormalities
- Request cord gases

If the infant meets eligibility criteria for cooling, please follow the guidelines below.

In order to be effective, cooling should commence as soon as possible and definitely within 6 hrs of birth. The decision to cool a neonate with HIE is made by the attending neonatologist or registrar.

INITIAL MANAGEMENT:

1-Cooling

Avoid overheating the baby

Nurse infant in an open incubator with no heat source at this stage

Insert a rectal temperature probe to 6cm, tape well, and monitor core temperature continuously.

Wrap the servo-controlled Tecotherm reusable mattress around the body of the baby. Aim for the target temperature of 33.5 ºC

On arrival in the NICU or before (ie during long distant transport where aEEG is available) apply aEEG

1.1 Active cooling

For 72 hours from the initiation of cooling. Aim is to achieve target temperature range within 1 hour. Hypothermia is maintained using the Tecotherm Neo cooling system, which induces hypothermia by circulating fluid within a special mattress.

1.2 Rewarming

When cooling is concluded the rectal temperature should be allowed to rise by no more than 0.2-0.3°C per hour, to 37± 0.2°C. The rectal temperature will be recorded hourly on the Daily Log forms. The infant's rectal temperature must be carefully monitored for at least 24 hours to prevent rebound hyperthermia, as this might be detrimental.
Remember to put the heating on the bed before rewarming is finished or the infant will go cold when the wrap is removed.

1.3 Discontinuing cooling treatment

Cooling may be discontinued if the following occur:

- If the aEEG becomes normal and the infant no longer has encephalopathy by 6 hours of age the need for continuing cooling can be reconsidered
- Clinical, EEG and imaging evidence of severe, irreversible brain injury
- Baby receives ECMO.

2- General Clinical Care:

2.1 Seizure therapy

Symptomatic seizures or frequent (>3/hr) subclinical (EEG) seizures will be treated with phenobarbitone 20mg/kg loading dose over 20 min IV repeated if necessary after 40-60 minutes, followed by 5-10 mg/kg/day.

If seizures persist, intravenous midazolam 100 micrograms/kg followed by 30-100 micrograms/kg/hour may be added. Further anticonvulsant therapy, if required.
Caution: watch temperature range more closely in infants treated with anticonvulsants or muscle relaxants as they may cool much quicker

2.2 Analgesic and sedative therapy

Stress may have adverse effects in asphyxiated infants and may influence the therapeutic effect of hypothermia. In addition, neonatal intensive care procedures may cause considerable stress to infants and cooling may also be associated with stress.
Signs of distress include tachycardia, facial grimacing and irritability. A heart rate consistently above 100 bpm in cooled infants strongly suggests that the infant is distressed. All ventilated infants should be sedated with intravenous diamorphine, loading dose 60 micrograms/kg over 30 minutes followed by 15-60 micrograms/kg/hour.
Non-ventilated infants who appear distressed should be treated with chloral hydrate 50 mg/kg.
Respiratory function must be monitored on these babies.

2.3 Fluid Management

Renal function is commonly impaired following severe perinatal asphyxia. The infant's weight, blood creatinine and electrolytes and urine output will guide fluid management.
As a guide restrict total fluids to 40 ml/kg/day. Infants in renal failure should receive a total of 30 ml/kg/24 hours plus any measured losses.
Boluses of 0.9% saline may be required to avoid hypovolaemia if the infant develops diuresis or if vasodilatation occurs during rewarming.
Measure blood glucose regularly
Consider withholding feeds until the infant is stable in case there has been ischaemic damage to the gut and start oral feeds after rewarming.

2.4 Ventilation
Infants may require mechanical ventilation including high frequency oscillation and inhaled nitric oxide if necessary. Blood gases will guide ventilatory requirements; as a guide PaO_2 should be maintained between 6-10 kPa and the $PaCO_2$ between 6-8 kPa.

2.5 Cardiovascular support
Alterations in heart rate and blood pressure are common during hypothermia. In general the heart rate is reduced and blood pressure increases with a reduction in body temperature. Most infants with a rectal temperature of 33.5 C will have a heart rate around 100 bpm and a mean blood pressure greater than 40 mmHg. A rapid rise in body temperature may cause hypotension by inducing peripheral vasodilatation.
Causes of hypotension should be sought and appropriate treatment provided. (see the guidelines for treating hypotension)

2.6 Sepsis
Antibiotic therapy may be given if clinically indicated. Avoid aminoglycosides because of risk of renal failure but use cefotaxime instead.

2.7 Investigations
Blood
Gas, lactate, U&E, Cr, Calcium, Magnesium
PT, APTT, Glucose, LFT's
FBC, C&S

Urine
Collect the first urine (measure creatinine/lactate ratio as measure for previous hypoxic stress)
ECG, CFM Monitor
Daily Cranial USS for first 72 hrs
MRI (Day 5-14)

2.9 Register with TOBY cooling Register (See Appendix 2)
A PIN number to anonymise data should be obtained by calling 01865 289735 during office hours.

A data form should be commenced at initiation of treatment,and submitted to the register at discharge, death or transfer. If no forms are available they can be downloaded at:
http://www.npeu.ox.ac.uk/tobyregister/

2.8 Follow-up
All babies who are cooled should be followed up regularly until 2 years of age. A data collection form will be provided by the register on which to record data on neuro-developmental impairment, growth and neurological status at 2 years.

CHECKLIST FOR COOLING
(cooling centre)

- Baby meets Group **A**, **B** and **C** criteria
- No contraindications to cooling present
- Discuss baby's condition and treatment options, including cooling, with parents and document in notes
- Initiate cooling as soon as possible
- Start CFM recording as soon as possible, but not necessarily before cooling is commenced
- Allocate baby a PIN from the Register and document relevant information on a Register data form (during office hours ring 01865 289 735)
- Monitor rectal temperature continuously, record hourly until 24 hours after Rewarming
- Maintain hypothermia for 72 hours then re-warm
- Complete all sections of the Register data form
- Arrange MRI between 5 and 14 days of age
- Submit MRI findings to Register
- Explain to parents need for continued follow up
- Submit follow up data to the Register following 2 year assessment
- NB: all data submitted to the Register must be anonymised, and identified only by the baby's registered PIN. Please ensure ALL item sent to the Register are clearly marked with the PIN
- Keep photocopies of all completed forms, clearly marked with the Register

PIN

Appendix 1 – How to Cool

What you need for cooling:-

1-TECOTHERM NEO device
2-Cooling mattress
3- Protecting foil interlayer
4-Rectal temperature probe (Please do not discard after the treatment, clean and send it for autoclaving)
5-Skin temperature probe (Please do not discard after the treatment, clean and send it for autoclaving)
6-Aquagel for rectal probe
7-Different types of “sticky tapes”
8-Scissors
9-CFM
10-Needle electrodes for aEEG
11-Small nappy
12-Cotton wool for collecting urine

TECOTHERM COOLING MACHINE

Setting up the Tecotherm system

- Connect the cooling mattress to the Tecotherm machine before turning power on.
- The mattress connections are located at the bottom right of the front panel.
- Turn machine on using green power button (bottom left of front panel)
- Check to see that coolant is running to the blanket
- If the coolant level is inadequate the machine will alarm and a blue light will be seen flashing

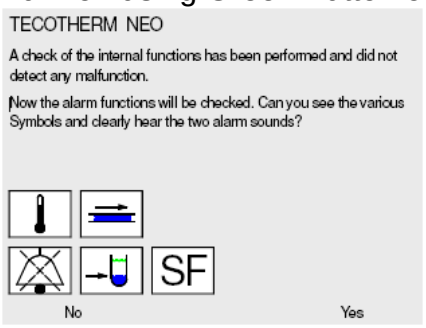
Filler bottle and connecting tubes

- If cooling level is inadequate the machine should be filled up using the filler bottle with tubes attached and connected to the Tecotherm machine using the 2 connection ports at the top right of the front panel labelled. The filler bottle needs to be held above the machine during filling.

Set-Up

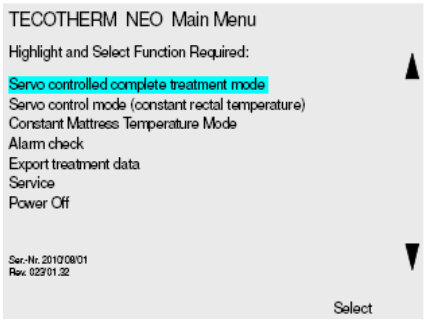
1. Plug in at Mains

2. Turn on using Green Button on Front of Tecotherm Neo

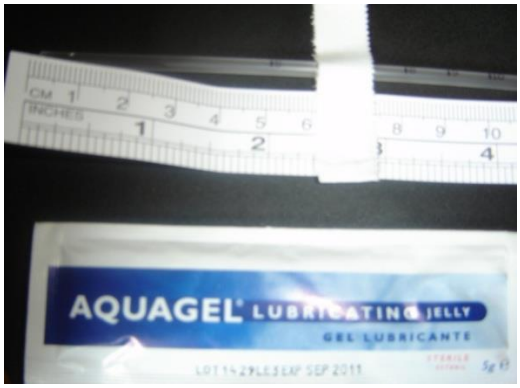


3. Confirm **YES** pressing key T1

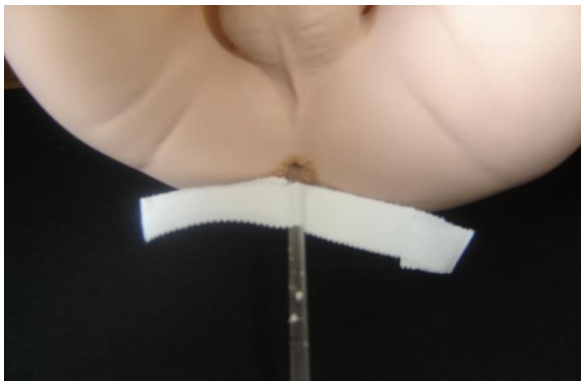
4. If **YES** TECOTHERM NEO Main MENU is displayed



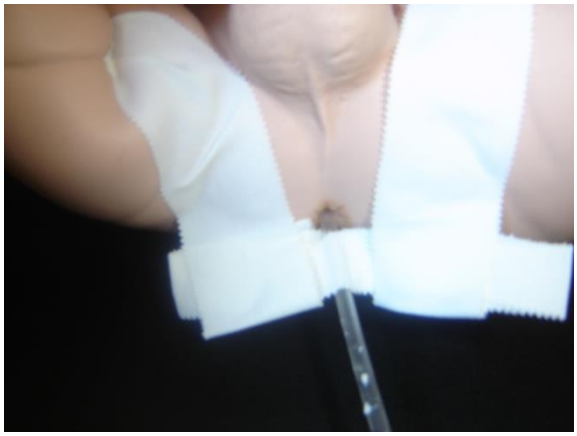
5. Place the baby on the cooling mattress with protecting foil interlayer between the baby and the matress. Insert rectal probe at 6 cms and secure it. Ensure the probe is connected to TECOTHERM NEO socket marked **R**
6. Insertion of rectal probe



Placing rectal probe at 6 cm



Tape probe along the thigh as shown



7. Attach the skin probe either on the forehead or the axilla and connect the other end to TECOTHERM NEO socket marked **S**

8. Press select and then start.

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Baby checks and Common postnatal ward problems

The *purpose* of the newborn examination is to:

- confirm normality
- screen for treatable pre-clinical congenital abnormalities
- provide parental reassurance
- provide parental health education in the early neonatal period.

Definitions

All newborns should routinely have a systematic, thorough and complete examination as part of their child health surveillance. This should ideally be between 6 to 48 hours of age.

Objectives

These guidelines will serve to support and direct doctors, ANNPs and midwives in carrying out the examination in a consistent and systematic manner.

- The newborn examination is an extended role for midwives and its performance should not derogate their primary duties.
- Appropriately trained midwives will be authorised to perform newborn examinations on well infants of ≥ 36 weeks gestation. Exclusion criteria for midwife examination are being drawn up but some are listed below. Dr Mupanemunda is in charge of this programme from the neonatal side.
- The examination should preferably be conducted in the presence of the mother.

Exclusion Criteria

The following material facts will <u>preclude</u> the midwife from undertaking the newborn examination:

- Infants with known or suspected malformations (usually detected antenatally).
- Infants with suspected chromosomal disorders.
- Infants born to mothers with poorly controlled diabetes.
- Maternal substance abuse.
- Significant maternal medical disorders (e.g. autoimmune disorders, if in doubt consult the neonatal registrar).
- Strong family history of any abnormalities (metabolic, endocrine or genetic).
- Other unique or extenuating circumstances – at the discretion of the midwife.

Procedure

- Obtain maternal informed consent for the examination.
- Review the maternal medical, obstetric (past and present) and social histories from the mother's medical records and, where necessary, by engaging mum.
- Note any significant family history especially in siblings and note consanguinity.
- Review the perinatal and postnatal history noting presentation at birth (vertex/breech), resuscitation details, and the infant's postnatal behaviour and progress. Enquire into feeding

habits, sleep pattern, passage of meconium and urine, and behaviour (e.g. type of cry and irritability).

- The examination must be conducted in a safe, warm, well-lit environment and the infant should be completely undressed.
- Observe the undressed infant for colour, posture, movement, dysmorphic features and any other variations from normal.
- Proceed to examine the infant gently and in a systemic fashion. (see **Appendix I** to this section for an expansion of this theme).

➢ **Head and neck**

Small or large head, head shape, exclude cleft lip and palate, red light reflex, ears – low set or malformed? Clavicles intact?

➢ **Respiratory System**

Colour, stridor, tachypnoea, and respiratory distress.

➢ **Cardiovascular**

Pulse rate and regularity, heart sounds, femorals.

➢ **Abdomen**

Organomegaly and patent anus?

➢ **Genitalia**

Non-ambiguous, testes descended, normal urethral opening and passed urine and meconium?

➢ **Skin**

Colour (jaundiced, bruised, birthmarks, stigmata of congenital infection?).

➢ **Musculoskeletal**

Limb shape and proportionality (proximal shortening?), syndactyly or polydactyly, hips stable? and any contractures?

➢ **Neurological**

Posture, tone, irritability, reflexes.

Documentation

Appropriate contemporaneous records of the examination must be made and appropriately filed in the parent held record with the pink copy filed in the medical records of the infant. Any deviations from normal must be highlighted and any subsequent actions taken noted in the infant's records and hand held records(essential).

Explain the procedure and your findings to the mother ensuring that the mother is made aware of any abnormal findings detected or other concerns of note, and what action you will be taking (e.g. requesting a paediatric review/senior review). A brief account of your discussions with the mother should be recorded in the infant's records.

Some common postnatal problems

Hips
If the hip examination is abnormal arrange for the infant to have a hip scan at Solihull Hospital (contact Linda Hill on ext 44443) or enter the babies details in the 'hips book' on the postnatal ward. ALWAYS discuss abnormal examination with registrar/consultant.
Infants with a family history of hip dysplasia, breech or transverse presentation, and hip contracture also require hip scans. Please refer to guideline on Hips.

Brachial palsy :
Please see under brachial palsy in the index.

Umbilical hernia

Umbilical hernias are common in infancy. They are due to incomplete closure of the ring of muscle around the umbilical ring through which the umbilical vessels enter the fetus.
Most umbilical hernias close spontaneously within 3-5 years. If the hernia is still present at the age of 3, referral to a paediatric surgeon is indicated.

Sacral dimple

Indications for spinal ultra sound

- sacral dimple only when base of dimple cannot be identified. Low dimples below the spine and close to anus less likely to be significant.
- sacral hairy patch
- sacral swelling

Arrange followup in consultant clinic after discussing this with him/her.

Skin tags

Pre-auricular skin tags and accessory digits refer as an outpatient
to Plastic Surgeons- Miss Lester. Do not tie off skin tags on a pedicle yourself.
Audiology apart from routine screening is not required. If antenatal renal scan normal, presence of pre auricular pits / tags does not warrant further renal imaging.

Polydactyly

Supernumary digits arise from the lateral surface of a digit, most commonly on the ulnar aspect of the little finger. They vary in size and shape, and can vary between being a small pedunculated nubbin of skin through to being a complete digit containing nail and cartilage.
Although most commonly an isolated anomaly, polydactyly may be associated with other syndromes so the baby should be carefully examined for other abnormalities. Refer to clinic at BCH Miss Lester and discuss with consultant.

Birth marks

Capillary Naevi

These 'stork marks' are seen on the nape of the neck and upper eyelids. Most fade rapidly during the early months and no follow up is needed. Occasionally can appear elsewhere on the body sometimes initially looking like a bruise. Naevi blanch allowing differentiation.

Mongolian or Blue spots

Well demarcated areas of increased pigmentation of skin found usually over lower back and buttocks seen most commonly in African and Asian origin children. The pigment is within the skin and borders are not palpable. They need no follow up.

Strawberry naevi/ cavernous haemangioma

Usually not present at birth and start as small bright red spots in the first few weeks of life. They increase in size for the first few months and then regress disappearing by 2 years of age. They rarely bleed although large ones can have this problem. No action is needed unless they are situated in a problematical position such as airway, anus, genitals or face or they become very large. For problematical lesions listed above referral to dermatology may be appropriate- discuss with consultant.

Port Wine stain

Always discuss with consultant. Most occur on the face although they can occur anywhere on the skin. Approximately 1 in 10 children with port wine stains will have underlying eye and brain problems. Eye referral will be needed as well as dermatology referral. Consider Sturge Weber if extensive.

Skin rashes

These are common and generally benign. Discuss with senior if any doubts.

Erythema Toxicum

Begins within 48 hours and resolves in a few days. Erythematous blotchy macules which can be 2-3 cm in diameter and have central vesicle. Commonly seen on trunk, face and limbs. Benign common condition.

Milia

Seen over the face and result from retention of keratin and sebaceous material. Appear as multiple white or yellow 1-2 ,mm papules. Disappear in a few weeks.

Sebaceous Gland Hyperplasia

Multiple tiny papules on nose, cheeks and upper lips of newborn. Manifestation of maternal androgen and resolve in a few weeks.

Epithelial Pearls

These are areas where cells are condensed into little cysts. Often seen inside mouth and will resolve spontaneously.

Purpuric spots

May be due to thrombocytopenia or congenital infections. Seek senior help.

Vesicles

In the presence of vesicles herpes simplex infection must be suspected. Seek senior advice. See Herpes guideline.

Breast Development

Maternal hormones may cause transient development of breast tissue in babies of both sexes. In girls there can be slight blood stained vaginal discharge. This resolves over several weeks. Reassure parents.

Undescended testes

1. if unilateral request GP review at 6 week check. Document on hand held record and counsel parents.

2. if bilateral discuss with consultant.
o exclude other abnormality e.g. PraderWilli, ambiguous genitalia, hypospadius
o refer to Paediatric surgeons

Testicular Torsion

In neonates, typically perinatal in origin. Tender, red firm and enlarged testis. Will not transilluminate. Usually unilateral (but can be bilateral). Seek senior advice.

Hydrocoele

Can be unilateral or bilateral. Skin may have bluish discolouration if large. Can fluctuate in size (if communicating). Has a distinct upper margin and transilluminates with outline of testicle visible.. Non-tender. Can be associated with a hernia.
No follow up is needed but give a full explanation to parents and make a note in the child health record. Most disappear over the first year. Advise parents to seek further advice if the hydrocoele persists beyond 12 months or is causing problems.

Hypospadias

May be associated with chordee. Check for other abnormalities and consider endocrine problems. Make sure testes have descended and baby is passing urine. Any case that is not straightforward must be reviewed by the registrar/ consultant. Refer to the urologists at the time of discharge .
Advise parents not to circumcise as foreskin may be needed for reconstruction

Forceps and ventouse marks

Ventouse extraction can cause suction marks and sometimes raw areas on the scalp. Forceps marks are less common than in the past as they are used less frequently.

Caput

Caput (or caput succedaneum) is oedema of the presenting part caused by pressure on the presenting part during a vaginal delivery. It crosses suture lines and is usually of no clinical importance and disappears during the first 48 hours after delivery. You should explain this to the parents especially if the caput is large.

More severe caput, often with damage to the skin, may be present on the infant's head after a vacuum extraction (when it is called a chignon).

Cephalhaematoma

A cephalhaematoma is a collection of blood under the periosteum. It is common, may be unilateral or bilateral, and appears within hours of delivery as a soft, fluctuant swelling on the side of the head. A cephalhaematoma never crosses suture lines.
Bleeding is caused by damage to capillaries under the periosteum of the parietal bone. Cephalhaematoma need no treatment. The reabsorption of blood may cause jaundice, however, which may require treatment. It can take up to 3 months before the cephalhaematoma disappears.

Subaponeurotic haemorrhage

A subaponeurotic haemorrhage is a collection of blood under the aponeurosis of the scalp. The subaponeurotic space is large and can contain a lot of blood. A subaponeurotic haemorrhage is not common. It presents as a boggy swelling of the head that crosses suture lines giving a diffuse swelling of the head. Blood can also track and cause bruising behind the ears and on eyelids. If severe can cause shock. Seek senior review.

Facial Palsy

Facial palsy is muscle weakness of one side of the face due to trauma to the facial nerve. The affected side of the face droops and the infant is unable to close the eye tightly on that side. When crying the mouth is pulled across to the normal side. The weakness usually recovers spontaneously in a few days or weeks and no treatment is needed. Discuss with on call consultant.

The asymmetric crying face mimics a facial palsy but the infant is able to close the eye on the weak side. Usually the weakness of the face is only seen when the infant cries and the mouth is pulled to the normal side. The weakness is due to congenital absence of the muscles on one side of the face and does not improve with time.

Eyes

If you are unable to see the red light reflex or have concerns about the reflex, please ask the paediatricians/senior to check the eyes for you. It may at times be necessary to dilate the eyes with eye drops in order facilitate the eye examination. To do this, instil **one drop** each of 0.5% cyclopentalate and 2.5% phenylephrine 60 minutes before the examination and repeat 30 minutes before the examination. The eyes should be well dilated by the time the two lots of eye drops have had their time to work. If concerns remain about the ophthalmic examination, the paediatricians should refer to the consultant ophthalmologist.

Renal pelvis dilatation : Please refer to guideline.

BCG : Please refer to guideline on page

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