THAMES VALLEY & WESSEX NEONATAL OPERATIONAL DELIVERY NETWORK

INSULIN INFUSION GUIDELINE

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Related documents	**References** BNF (2021) British National Formulary- Online version. Accessed 1st February 2021 at https://bnf.nice.org.uk/ Hardy,A.R et al (2018) Model based insulin absorption into intravenous infusion sets in adult and neonatal intensive care units. IFAC-Papers on line, Vol 51, Issue 27, pp24-29. Kairamkonda.V and Stachow.L (2018) The use of human soluble insulin (Actrapid) on the neonatal unit. University Hospital of Leicester NHS Trust. Found at https://secure.library.leicestershospitals.nhs.uk/PAGL/Shared%20Documents/Insulin%20Use%20on%20NNU%20UHL%20Neonatal%20Guideline.pdf Kelly.J.L (2014) Continuous insulin Infusion: When, Where and How? Diabetes Spectrum, Vol 27, No 3, pp218-23 Leton. N (2017) Management of neonatal hyperglycaemia Yorkshire & Humber Neonatal ODN (South) Clinical Guideline. Found at file:///C:/Users/kreed/Downloads/Hyperglycaemia%20FINAL%20Dec%202017.pdf Medusa (20201) Insulin (soluble) human. Intravenous-Child. Medusa injectable medicines guide, Found at https://www.rcpch.ac.uk/resources/medusa-injectable-medicines-guide

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

Insulin Infusion: Neonatal Nursing Guideline.		
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Aim of Guideline Framework

To provide a framework to ensure that all infants requiring an insulin infusion are optimally cared for.

1.0 Scope of Guideline Framework

The guideline applies to all infants requiring within Thames Valley and Wessex Neonatal Network Operational Delivery Network.

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

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

2.0 Guideline Summary

- Refer to local policy for how to make up the insulin infusion.
- Insulin should be stored according to the manufacturer's guidelines.
- In neonatal practice two approaches may be taken when selecting the IV line for administration;
    - The insulin infusion can be given via its own dedicated IV access to prioritise the need for the infusion to be run without interruption, flush, or bolus.
    - Or the insulin is administered through a PVL or CVL alongside the Parenteral Nutrition or IV glucose. This is to ensure that if the insulin infusion is interrupted the supply of 'sugar' to the infant would be interrupted at the same time, and reduces the risk of increasing hyperglycaemia. and a filter should NOT be used on the administration set.

- Insulin syringes should always be used for drawing up insulin, and should match the strength of insulin being used.

- Insulin can be adsorbed by plastic, so when preparing an insulin infusion the regime used should include a 'set aside' time period, to minimise the effect of this adsorption.

- IV insulin must be administered via a continuous syringe pump.

- Insulin infusions should not be filtered.

- The starting dose for an insulin infusion is usually 0.05units/kg/hr

- The baby's blood sugar should be checked 1 hour after commencing the infusion.

- It is usual practice to titrate the insulin dosage in increments between 0.01 and 0.05units/kg/hr every 2-3 hours if required, based on the blood sugar response.

- Any baby receiving an insulin infusion is at risk of hypoglycaemia- so staff caring for such a baby with an insulin infusion must be meticulous in the care they give.

- Ensure that the baby's IV maintenance infusion or feeding regime continues uninterrupted during the insulin infusion.

- Recheck blood sugar 2-4 hours after ceasing an infusion.

- Insulin infusions need to be replaced every 24 hours.

Insulin infusions are identified by many neonatal unit nursing staff as stressful and unfamiliar aspects of their nursing practice, so this guideline is written to provide nursing staff with a clear outline of why, how and when to administer an insulin infusion to the neonate.

3.0 Background information

Insulin is a hormone secreted by beta cells in the pancreas, which causes increased glucose uptake by adipose tissue and muscles, and suppression of hepatic glucose release. In a healthy individual the body secretes insulin in two main cycles. Firstly through 'basal insulin' (a low and steady secretion of background insulin that controls the glucose continuously released from the liver) and secondly by 'meal-time bolus' insulin (secreted in response to glucose absorbed from food and drink).

In adults and children insulin is most commonly given to medicate for symptoms of the medical condition diabetes, which is a lifelong condition that causes a person's blood sugar level to become too high. There are two main types of diabetes; type 1, where the body's immune system attacks and destroys the cells that produce insulin. Or type 2 where the body does not produce enough insulin, or the body's cells are resistant to the effects of insulin.

It is extremely uncommon for a neonate to have diabetes, however insulin infusions may be required to manage hyperglycaemia by lowering blood-glucose concentrations and helping to prevent associated microvascular, macrovascular and metabolic complications of hyperglycaemia.

Hyperglycaemia in the neonatal period develops as a result of various mechanisms including;

- Iatrogenic causes- usually related to a too rapid intravenous infusion of glucose during the first few days of life in very low-birth-weight infants (< 1.5 kg).

- Physiological stress- caused by surgery, hypoxia, respiratory distress syndrome, or sepsis; particularly fungal sepsis. These bodily stressors increase hepatic glucose production.
- Preterm infants have limited insulin secretion capacity, which limits glucose disposal and activates hepatic glucose production, both of which lead to hyperglycaemia.

  Many preterm infants are growth restricted and have experienced intermittent to persistent hypoxia, which increases secretion of catecholamines that further suppress insulin secretion.
- Absence of enteral feeding or delayed onset and slow advancement are common in very preterm infants. These can have the effect of limiting production of gut incretins and their potential stimulation of insulin secretion.
- High doses of intravenous lipids can affect the gluconeogenic pathway.
- Longer term, intake of nutrients in preterm infants has been weighted to carbohydrate and lipid rather than protein, leading to fat accumulation and intolerance to glucose disposal. Both of which can contribute to persistence of hyperglycaemia well into the full enteral feeding phase of preterm infants' NICU stays.

Three types of insulin are available in the UK: human insulin, human insulin analogues, and animal insulin- although animal insulins are no longer used for new patients. Insulin is inactivated by gastro-intestinal enzymes and must therefore be given by injection. The subcutaneous route is ideal in most circumstances, but soluble insulin administered intravenously is the most appropriate form of insulin for use in neonates with hyperglycaemia.

Insulin preparations can be broadly categorised into three groups based on their time-action profiles: Short-acting insulins (including soluble insulin and rapid-acting insulins), intermediate-acting insulins and long-acting insulins. Short-acting insulins are used in neonatal hyperglycaemia, due to their short duration and relatively rapid onset of action.

A soluble insulin is used because being soluble it can be given intravenously. W*hen injected subcutaneously*, soluble insulin has a rapid onset of action (30 to 60 minutes), a peak action between 1 and 4 hours, and duration of action of up to 9 hours. However, *w*hen injected intravenously*,* soluble insulin has a short half-life of only a few minutes and its onset of action is instantaneous.

Human soluble insulin is the generic name for the type of insulin used for insulin infusion on the neonatal unit. Brand names of this type of human soluble insulin available in the UK are Humulin S and Actrapid.

Before an insulin infusion is commenced to manage hyperglycaemia, a number of simple practical measures can be taken which may bring the baby's blood sugar back into the acceptable range and avoid the need for insulin. Check with the medical team whether any of the points below might be applicable;

- Reducing the concentration of glucose in intravenous maintenance fluids. This may be changing from glucose 10% to 5% glucose or changing from standard Parenteral Nutrition (PN) to a 'lite' or reduced glucose PN, or even a bespoke PN.
- Changing the diluent used for infusions. For example can IV morphine made up in 10% glucose be changed to 5% glucose, 0.45% sodium chloride / 0.9% sodium chloride or even water for injection. If the baby has a number of infusions running, changing the diluent fluid in these can make a significant contribution to blood sugar.
- Consider if there is a contributing factor such as the baby has just returned from surgery- the physiological stress from this event is likely to settle rapidly and if a blood sugar is checked again in 1-2 hours the hyperglycaemia may be a transient event.

- If the baby is on a medication known to raise blood sugar- for example steroids such as dexamethasone- the blood sugar may be allowed to rise to a higher level than usual (ie >12mmol, rather than,10mmol) before action is required.

When considering if it is appropriate to alter the glucose concentration of the neonates' intravenous fluids the medical team will often calculate the Glucose Infusion rate (GIR). This is a formula that allows the amount of carbohydrate a person receives per minute to be calculated. The answer is given in milligrams of glucose per kilogram body weight per minute (mg/kg/min). A 'normal' glucose infusion rate for full-term infants would generally be 4 to 6 mg/kg/min, while 'normal' rates for premature infants' change according to the age in days of the infant. Common practice would be to start at 4-8 mg/kg/min with the aim of reaching 11mg/kg/min between day 4 to 8 of age.

<u>For calculation of GIR from glucose infusion.</u>

$$\text{GIR (mg/kg/min)} = \frac{\text{Rate (mL/h)} \times \text{\% glucose}}{\text{Wt (kg)} \times 6}$$

<u>For calculation of GIR from oral feeds (approximate value~):</u>

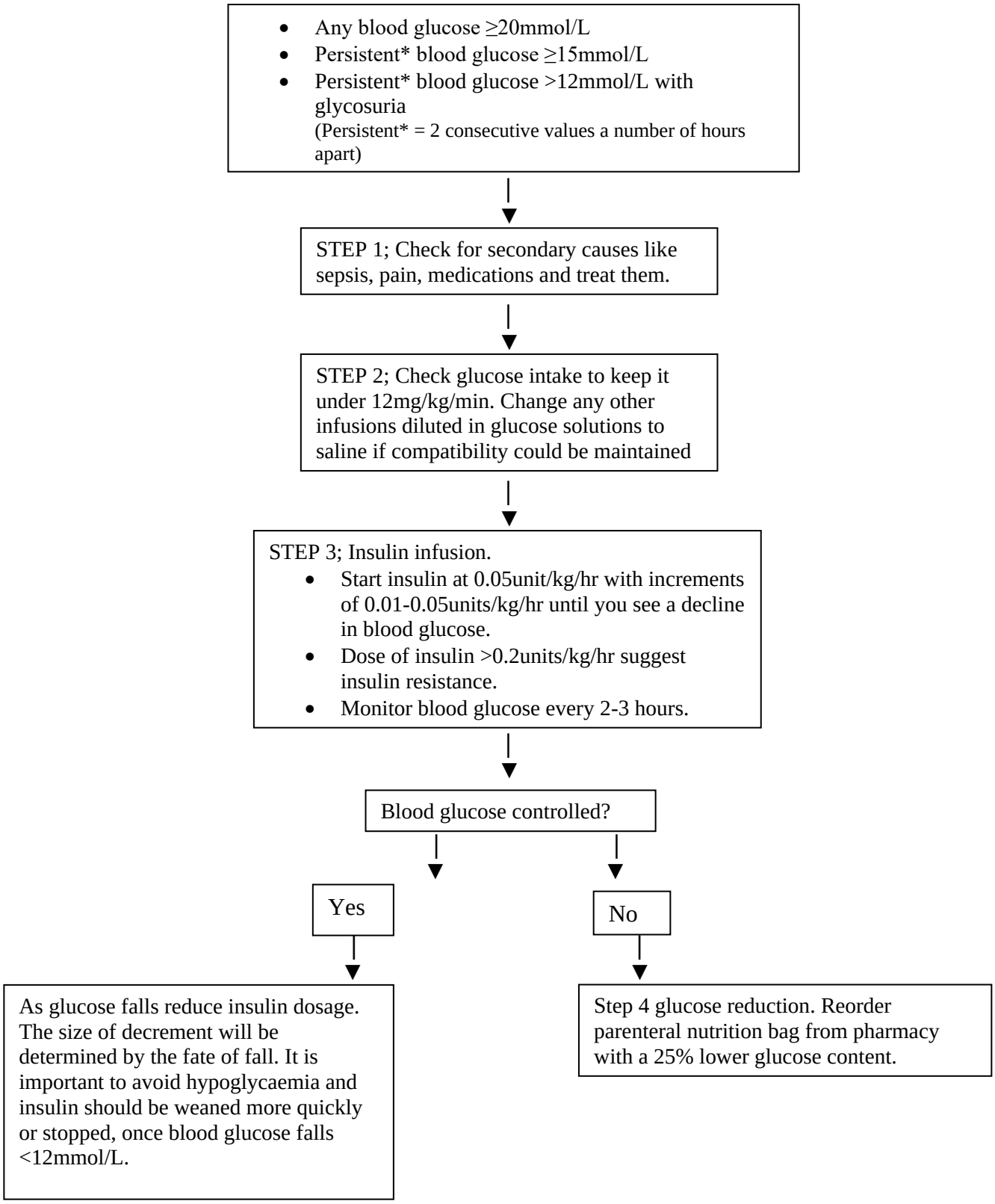
$$\text{GIR (mg/kg/min)} = \frac{\text{Rate (ml/kg/d)} \times \text{sugar content of milk (g/dl)}}{144}$$

The amount of lactose/glucose in milk will be required for these equations, and are listed below. However studies on breast milk (term, preterm, donor) show large variations in sugar content (5.5-9.6 g/dL) so accuracy will be limited for breast milk fed babies.

- Breast milk = 7.1 g/dL,
- Term formula = 7. 1g/dL,
- Preterm formula = 8.5 g/dL ~

Each unit will have a flow chart for the management of hyperglycaemia- which will guide staff on which action to take in response to the hyperglycaemia. See overleaf in Figure 1, a clear and helpful example of one from the West of Scotland MCN.

Figure 1. Flowchart for the management of Hyperglycaemis in Neonates .(NHS GGC. 2020)



4.0 Practice Guidelines

5.1 Preparing the insulin infusion

The procedure for making up the infusion will vary from one hospital trust to another, so cannot be outlined within this guideline, but a range of principles will apply, regardless of how the infusion is made. These can be found below;

- Refer to local policy for how to make up the insulin infusion.
- Only appropriately trained staff should be preparing the insulin solution for administration. Whenever possible one of the staff preparing the insulin solution will be an experienced QIS neonatal nurse and will have prepared an insulin infusion before.
- Human soluble insulin should be stored according to the manufacturer's guidelines which general principles include;
    - Keep the vial in the outer carton in order to protect from light.
    - Ideally store in the refrigerator at a temperature of 2-8°°C, but always below 25°C.
    - Can be stored after opening for a maximum of 6 weeks- so staff are advised to document the opening date of the insulin on the side of the vial
    - If insulin is removed from the fridge for use, it is stable as long as the environmental temperature does not exceed 25°C.
    - Clear insulin does not need to be mixed (agitated) before use.
    - Do not use the product if you notice that the solution is not clear, colourless and aqueous.
    - Insulin which has been frozen must not be used-so staff should take care that the insulin stored in the fridge does not touch the back plate which can form ice and would denature the insulin.
    - Do not store undiluted drug solution in plastic syringes. Dilute immediately after drawing up, as the insulin solution can react with the plastic causing formation of a haze. If this occurs, the solution and the syringes should be discarded immediately, and replaced with fresh solution.
- There is variation in practice between neonatal units as to which intravenous line the insulin infusion is administered, and whether it is given in its own separate line or administered with maintenance fluids. Staff members must follow the practice used in their local unit but be aware of the variation in practice that is possible and advantages and disadvantages that each approach brings.
- In some units the insulin infusion is given through its own dedicated IV access. This is because the insulin infusions must not be flushed, or bolused due to the extreme sensitivity of the body to dose changes. By administering the insulin infusion separately this removes the risk of any unintended fluctuations in the insulin infusion if the line is being used for other infusions or medications. However, if the infant's source of energy input is disrupted- for example the peripheral venous line tissues, and the baby is not receiving its maintenance fluids, the insulin infusion will continue and there is a high chance of hypoglycaemia occurring.
    - Once in the blood stream, insulin has a half-life of 5-6 minutes, so where possible the baby should have spare IV access. This is so that if one IV access stops working the infusion can be transferred rapidly to another cannula. However the insulin will continue to have some

effect on the cells for some hours, so loss of intravenous access is not an emergency situation.

- A central venous line (CVL) is generally NOT suitable for an insulin infusion running on its own. Firstly because a CVL usually needs to be used for a number of medications and parenteral nutrition. Secondly an insulin infusion runs at a very low volume per hour, so running on its own would not be enough volume to keep a CVL patent.

- Other units choose to run the insulin with an energy source, for example PN or glucose infusion. This means if the IV line stops working the baby will does not receive excess amounts of either insulin or glucose (energy) as administration of both will be interrupted at the same time. However, in this situation there is likely to be some fluctuation in insulin administration, if the rate of maintenance fluids is altered, or if medications are administered through the same line that the insulin is being administered.

- Insulin comes in more than one preparation and strength- depending on the manufacturer and the separate versions of the insulin brand (ie 40 units/ml, 100units/ml/ glass vial, Pen cartridge, concentrated syringe from pharmacy or ready diluted solution.) So take great care to check the strength/ formulation of the product to be used.

- Insulin syringes should always be used for drawing up insulin -these are special syringes marked with graduations for the number of units of insulin- rather than the volume of drug in mls and and should match the strength of insulin being used. For example in the UK insulin used for humans is always U100 insulin, (meaning 100 units per 1ml of insulin) so U100 insulin syringes should always be selected for use, and should be the only type supplied to a ward.

- Insulin can be adsorbed by plastic- which means insulin sticks to the plastic giving set tubing causing a decrease in the concentration of the insulin solution delivered through the giving set. Because of this it is usual practice to make up the insulin infusion and push it down through the plastic giving set and tubing, but to not immediately attach this to the patient. Instead it is 'set aside' for a period of time which allows the plastic binding sites to be saturated. Before attaching to the patient, the infusion should then be flushed by 5-10mls so the solution sitting in the giving set is pushed out of the tubing and new 'fresh' solution is within the giving set.

- There is a wide range of variation in the literature defining the correct 'set aside time' from 10 minutes to one hour. However the nationally recognised Medusa Injectable Medicines Guide (IMG) recommends 10 mins, and these monographs are all agreed and ratified by the UK's National Neonatal and Paediatric Pharmacy Group and endorsed by the RCPCH.

- Some units may try to bypass the problem of insulin binding to the plastic by purchasing low adsorbing tubing, but these are expensive, so not commonly used.

- Do not use a filter for an insulin infusion as this can 'filter out' some of the insulin, reducing the amount of insulin that is administered to the baby.

- An insulin infusion can be made up using 5% Glucose, Sodium Chloride 0.45%, Sodium Chloride 0.9% or Glucose 10%.

- The infusion will be prescribed in units/per kilogram/ hour (units/kg/hr).

- The most common way to make up insulin for use in neonatal units is to take 5units and dilute to a final volume of 50 mls with Sodium Chloride 0.9%. An infusion rate of 1ml/kg/hr of this solution then provides a dose of 0.1units/kg/hour.

- The infusion rate can be calculated using the following formula;

- Insulin infusion rate (ml/hr) = $\frac{\text{Dose (units/kg/hour) x patient weight (kg)}}{\text{Concentration (units/ml)}}$

Question for drug checkers	Yes/ No
Is the patient's current weight correctly recorded on the drug chart?	
Is the prescription signed?	
Is the prescription in units/kilo/hour?	
Has the correct dose been prescribed based on the weight? *Each checker to check dose separately.*	
Is the medication thoroughly mixed and all lines purged?	
Has the syringe and giving set been set aside for minimum of 10 mins?	
Is the infusion pump set to the correct rate/dose.?	
Are baby and drug details programmed correctly into the pump - where this is possible?	

5.2 Commencing the insulin infusion

- Insulin given intravenously takes effect very rapidly, but also has a short half-life so requires continuous intravenous infusion for effective treatment.

- IV insulin must be administered via a continuous syringe pump, to ensure an even supply and accurate administration of insulin.

- The starting dose for an insulin infusion is usually 0.05units/kg/hr.

- Two registered professionals must set up and check initial insulin infusion rate and for each rate change. This is recorded by both signing the prescription for administration.

- Insulin infusions are usually run as 'extra', or in addition to the baby's total fluid volume. In part because it is usually a very small fluid volume per hour, and in part because the infusion is likely to change rate frequently, as the insulin dose is titrated up or down according to the baby's blood sugar.

- If using a PVL, flush the line before commencing infusion to ensure patency- as it will not be possible to flush the line afterwards.

- Start infusion at the prescribed dose and rate then recheck blood sugar after 1 hour.

- If using a PVL, it should not be flushed or used for bolus medications during the insulin infusion, as a bolus of insulin will be given. In addition the PVL should not be used after the insulin infusion has been discontinued, as a significant dose of insulin will remain in the PVL hub and tubing. Because of this it is recommended to label the PVL as in use or previously used for insulin, so that colleagues will not use it by mistake.

- If running the insulin infusion alongside other infusions, label the distal end of the infusion administration line near the infant, to ensure the insulin infusion continues without interruption and is not clamped off or disconnected accidentally.

5.3 Ongoing care

- The infant's blood sugar should be checked regularly whilst they are receiving an insulin infusion. The exact frequency will be according to local protocol and may also vary due to the stability of the blood sugar levels and the baby's skin integrity. This might be every 1-2 hours if the blood sugar level is unstable, moving to a minimum of every 4 hours when the blood sugar is stabilised.

- It is usual practice to make hourly observations and recording of
    1. Heart rate
    2. Respiratory rate
    3. Oxygen saturations

- In addition, 4-6 hourly monitoring of blood pressure and temperature should occur.

- Insulin infusions need to be replaced every 24 hours.

- Due to the short half-life the insulin should be prepared and changed before the original syringe runs out. This ensures the insulin infusion is not stopped for prolonged periods.

- If the insulin and/or glucose infusion are disconnected from the patient, new solutions should be made up and new giving sets should be used.

- If the line through which the insulin is being administered stops working, the baby's blood sugar may rise, because it has not received the insulin, rather than because it requires a higher dose of insulin. Therefore, do not increase the insulin infusion rate until it is certain the insulin infusion has been administered through a patent line, at the prescribed rate for a minimum of 1.5 to 2 hours.

- Any baby receiving an insulin infusion is at risk of hypoglycaemia. Either because the blood sugar falls more rapidly than expected, and hypoglycaemia occurs or because an error is made with the preparation of the insulin infusion and /or its administration.

- Hypoglycaemia in an infant is defined locally by each unit, but is generally accepted to be when a baby's blood sugar falls to 2.6mmol/L or lower. Signs and symptoms of hypoglycaemia in babies can include irritability, jitteriness, seizures, hypotonia, lethargy, poor feeding, apnoeas, temperature instability, sweating, tachycardia and cyanosis. If the neonatal hypoglycaemia is sufficiently severe it can also cause brain injury and long-term neurodevelopmental impairment.

- In order to minimise the chance of hypoglycaemia occurring staff caring for a baby with an insulin infusion must be meticulous in the care they give. Blood sugar measurements should not be delayed, and any changes in insulin infusion rate should be discussed with a medical or nursing colleague - to ensure both parties agree what, if any, change should be made. Any changes to the insulin infusion rate should be witnessed by a second member of nursing staff, and documented and signed for in a designated place.

- Any baby receiving an insulin infusion is at risk of low potassium in the blood stream- known as hypokalaemia. Intravenous insulin causes hypokalaemia by shifting potassium from the intravascular to the intracellular space. Hypokalaemia is a potentially serious side effect, therefore it will be usual medical practice to monitor serum potassium concentration at least daily and aim to maintain it in the reference range (3.5–5 mmol/L).

- Urine analysis testing should be carried out at least every 12hrs to monitor urinary glucose. This is considered to be a helpful indicator of how well controlled the hyperglycaemia is. However, the

presence or lack of glucose in the urine should not be used on its own as a reason to start or stop an insulin infusion.

- It is usual practice to alter/ titrate the insulin dosage in increments between 0.01 and 0.05 units/kg/hr every 2-3 hours, if required, based on the blood sugar response. This is usually guided by an algorithm which is part of the individual baby's insulin prescription. **Staff must use the algorithm provided by their local hospital**; however, for information, an example algorithm can be found on page 16, showing practice guidance for the Oxford Newborn Care Unit.

- The insulin administration algorithm is a definite guide for practice- but there can be some need to flex this guideline following a discussion with the medical team. Particularly if the baby's blood sugar is very erratic, unresponsive, or if there is a sudden change in the baby's care, for example line /access issues. The table below outlines some basic principles that will guide health care professionals' thinking.

Figure 2. Chart showing clinical indications for altering insulin infusion rate.

Action to insulin	Situation when to make change
Insulin increase	-Blood sugar rising -Blood sugar elevated and unresponsive- despite insulin infusion ongoing
Static insulin	-if rate change recently made -if blood sugar stabilised, insulin still required.
Reduce insulin	-Blood sugar level falling fast -Blood sugar level nearer to 'normal'- i.e. 7-9mmol, when a chance of overshooting and going too low
Stop insulin	-Blood sugar <7mmol -Blood sugar coming down exceptionally fast- and may overshoot and go hypoglycaemic.

- Watch the insulin infusion site carefully- particularly if it is running through its own PVL, as such a small volume of insulin will not clearly show up as swelling or extravasation for many hours after the PVL has stopped working properly.

- Be aware of normal defined blood sugar range/ protocol for your area, especially if a guideline may have been recently updated or amended

- Ensure that IV maintenance infusion or feeding regime continues uninterrupted during the insulin infusion. If the supply of energy is suddenly stopped or reduced then the risk of hypoglycaemia rises significantly.

5.4 Discontinuing the insulin infusion.

- Recheck blood sugar 2-4 hours after ceasing- to review effect. Unless there had been a very quick drop in Blood sugar- where an earlier check may be required to ensure hypoglycaemia not occurring.

- If the insulin ran through a separate PVL, do not flush the PVL and do not use for other purposes- Label the PVL clearly as an insulin PVL- so future staff coming onto a future shift are aware not to use it, except for further insulin infusion.

- On the occasion where there is an urgent need for IV access, and the only option possible is this insulin PVL, it is possible to remove the T-piece and all extension tubing and just flush the cannula

at the junction with the skin. This will mean the volume of insulin potentially bolused into the baby is minimised to 0.1-0.2 mls. This should only be done with medical team agreement where no other option is available and the blood sugar should be checked within one hour of the flush being performed.

5.5 Parents

- Keep parents informed about their baby's condition, and the most current finding/ concerns/ plans for care.

- Encourage and support parents to be involved with their baby and their baby's care as much as possible. For example facilitating cuddles, taking photographs, enrolling in electronic video sharing sites such as Vcreate.

5.6 Staff

- All staff should receive training in neonatal hyperglycaemia and the administration of an insulin infusion. This should be at the relevant point in their progress through the unit, for example when a patient presents requiring insulin, or during the ITU orientation phase.

- Staff should work together with their employers, to take responsibility for updating their knowledge and skills in hyperglycaemia and administration of insulin infusions. This is likely, but not exclusively, to include; e-learning, reading research papers, keeping up to date with unit guidelines, attending clinical practice study days/ conferences/ seminars or webinars covering this area of practice.

- Insulin infusions are identified by many neonatal unit nursing staff as stressful and unfamiliar aspects of their nursing practice, so staff should be aware of sources of support, particularly in the practice setting where an insulin infusion could be unexpectedly required. Sources of support should include;

    - Senior nursing colleague
    - Unit/ Network nursing guideline or SOP
    - Medical Hyperglycaemia guideline
    - Unit pharmacist and on call pharmacist.
    - Local SOP/ Guideline
    - Network Level three Neonatal Unit

- It is best practice for one of the nurses making up an insulin infusion to be an experienced neonatal nurse, who has made up and commenced an insulin infusion previously. This can best be achieved by staff being required to have documented competence in administration of insulin infusion before they can be first checker for this medication.

5.6 Audit

- Audit should play a vital part in ensuring the quality of care that is delivered for all nursing practice including insulin infusion practice. It also identifies areas for improvement and staff development. Therefore every health care provider must support and participate when required in;

    - Benchmarking of insulin infusion practice – a minimum of every three years
    - Review of relevant guideline and drug monographs- a minimum of every three years
    - Feedback using local incident reporting system when errors or near miss events occur.

- Following this audit there should be evidence that action has been taken as a result of the audit / benchmarking that occurred. Otherwise the audit will have been only an administrative exercise, with no real effect on maintaining or enhancing best practice.

6.0 Appendix

Fig 3. Example of an Insulin prescription document- that can be amended according to the baby's weight

NEONATAL UNIT — calculated NEONATE/ INFANT INSULIN - INFUSION CHART — Oxford University Hospitals

(alternative Patient Addressograph/ Sticker)

ENTER in YELLOW BOX — PRINT DATE 11/06/2021

Patient Surname		WORKING WEIGH (in kg; max 7kg)	1.00 kg (check weight each time) — EXPIRY 12/06/2021
Patient Firstname			
Hospital Number		Units to add in 50ml (only multiples of 5units: min 5units & max 25units)	10 units (check each time)
Date of Birth		(=5units, 10units, 15units, 20units, 25units insulin)	

Instructions:

INFUSION MANAGEMENT of HYPER-GLYCAEMIA* in Neonates/Infants

Draw up 10 units of Actrapid® (100units in 1ml) with an **INSULIN SYRINGE (with a 'unit scale')** and ADD this to 20ml of 0.9% sodium chloride in a 50ml syringe, and **mix thoroughly, THEN make up to final volume of 50ml** with sodium chloride 0.9%. Prime the line, leave the mixture for at least 10 minutes then flush the line through before connecting to the baby. **DO NOT USE A FILTER.**

IF CONCENTRATION CHANGES THEN start NEW Prescription - REVIEW DAILY

THE **FINAL CONCENTRATION** IS **0.20 units/ml**

Syringe Made up

WORKING WEIGHT	**1.00 kg**	*Restricted weight range 0.3kg to 7kg*	**Date**	**By**	**Checker**
Start dose & Range	0.05 units/kg/hour (= 0.25 ml/hour **of 10 units in 50ml**)				
to	0.10 units/kg/hour (= 0.50 ml/hour **of 10 units in 50ml**)				

Frequency of blood sugar level checks - **see Neonatal Unit Guideline.**

For start & stop of insulin - see Guideline

Blood glucose*	**Insulin dose***	**Standard flow rate**
less than 3.5mmol/L	**NO INSULIN, but BOLUS of 2 ml/kg 10% dextrose =**	**2.0 ml of 10% dextrose**
4 to 7mmol/L	**NO INSULIN**	
(**May** *7.1 to 10 mmol/L*	0.025 units/kg/hour	0.13 ml/hour **(of 10 units in 50ml)**
10.1 mmol/L to 14 mmol/L	0.05 units/kg/hour **to** 0.074 units/kg/hour	0.25 ml/hour **(of 10 units in 50ml) to** 0.37 ml/hour **(of 10 units in 50ml)**
14.1 mmol/L to 18 mmol/L	0.075 units/kg/hour **to** 0.10 units/kg/hour	0.38 ml/hour **(of 10 units in 50ml) to** 0.50 ml/hour **(of 10 units in 50ml)**
18.1 mmol/L to 22 mmol/L	0.11 units/kg/hour **to** 0.15 units/kg/hour	0.55 ml/hour **(of 10 units in 50ml) to** 0.75 ml/hour **(of 10 units in 50ml)**
more than 22 mmol/L	**>>>CALL DOCTOR/ PRESCRIBER/CLINICIAN<<<**	
(prescriber, if needs cont.)	(0.20 units/kg/hour)	(1.00 ml/hour of 10 units in 50ml)

Prescriber Signature

(Print)

Date

Initial rate to start **units/kg/hour**

equals **ml/hour**

*adapted from 'Guy's and St Thomas', King's C & ULH April 2020 (Admin updated as per Medusa injectable monographs published 2019)

Date	**Time (24hour clock)**	**Blood Sugar**	**Current Insulin Dose**	**Updated Prescribed Insulin Dose**	**Level taken by**	**Checked by**
dd / mm/ yy	e.g. 23:15	mmol/L	Units/kg/hr	Units/kg/hr	*(a signature)*	*(signature(s)*
_ / _ / _	_ : _					
_ / _ / _	_ : _					
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Potassium level *3.5 - 6 mmol/L* time: 24 - hour clock	**Before** started _____mmol/L **THEN** time _ : _	4-6 hours level _ mmol/L time _ : _	9-12hours level _ mmol/L time _ : _	Further level _ mmol/L time _ : _	If potassium level still unstable, then **call** clinician	

PM Windscheif at John Radcliffe [NEOINS]Check R.Welsh, Aug 2011d/with Dr E. Adams a. C. Convery — EPSAM approval Nov2011 page 1 of 1

Version Control:

Version	Date	Details	Author(s)	Comments
Draft	August 2021	New Guideline produced by the TV&W Neonatal ODN Quality Care Group circulated to TV&W Lead Nurses for comments/feedback.	KR (Chair)	
1	16th August 2021	Actions on LM's feedback by KE and CL. All other comments were regarding grammar and have been amended. Guideline has gone back to author, KR, for clarification on the outstanding points.	KR (Chair)	Outstanding: Pg. 7 – does something need to be included after 'However' Pg. 7 – Flowchart – is there one that could be used from one of our Networks Pg. 12 – question do we all use the figure of 2.6mmol Pg. 12 – where is the algorithm from?
1.1	2nd September 2021	Actions on SP's feedback by KE and CL. Typos corrected. Two changes: Saline changed to 0.45% and 0.9% sodium chloride Appropriate trained clarified to experienced neonatal QIS nurse	KR (Chair)	
1.2	14th September 2021	CL added comments by MJ, NB, SH		
1.3	07/10/2021	KR made changes following review and feedback comments.		Returned Version 1.3 to CL and GO, with query about unifying practice across the ODN.
1.3	17/03/2022	V1.3 shared with Governance Forum for ratification		V1.3 Ratified 17th March 2022
Review Date:	**March 2025**			