East of England Neonatal ODN
(Hosted by Cambridge University Hospitals)

# Clinical Guideline: Neonatal Drug Infusion guideline

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**For use in:** EoE Neonatal Units
Guidance specific to the care of neonatal patients.

**Used by:** Neonatal medical and nursing staff, Neonatal Pharmacists

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| Neonatal Clinical Oversight Group | |
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**Ratified by ODN Board:**

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|---|---|
| **Date of meeting** | |

# Neonatal Drug Infusion Guideline

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# 1 Introduction

A national framework for standardisation of drug infusion concentrations in neonates and children was published in November 2024[1]. The aim of this framework was to support a national drive to improve safety and efficiency around the use of drug infusions, thus allowing development of 'smart-pump' drug libraries, development of pre-made licensed formulations and improve safety around use of infusions for patients that are transferred between different units.

The framework has been designed to use a number of fixed standard concentrations of infusions for each drug, that allow doses to be measured on a syringe pump for extremely low birth weight neonates upwards.
The framework is flexible enough to allow a more concentrated solution to be used to minimise impact on fluid requirements and to allow a more dilute concentration to be used when weaning specific medicines.

In addition to the framework, this guideline will cover the governance around the use of IV syringe pump drug libraries, which will also allow improved safety around drug administration.

This guideline also provides advice on how to minimise inconsistent drug delivery of short half-life medicines, in line with national advice issued by NPPG and BAPM in Nov 2024[2]

# 2 The Neonatal Infusion Framework

Concentrations of drugs, which should be used for neonates are listed as follows

| Medication | Option | Concentration |
|---|---|---|
| **Adrenaline** | 1 | 0.2 mg in 20mL |
| | 2 | 0.4 mg in 20mL |
| | 3 | 0.8 mg in 20mL |
| | 4 | 3.2 mg in 20mL |
| **Amiodarone** | 1 | 62.5 mg in 50 mL |
| | 2 | 125 mg in 50 mL |
| | 3 | 600 mg in 50 mL |
| **Atracurium** | 1 | 62.5 mg in 50mL |
| | 2 | 125 mg in 50mL |
| | 3 | 250 mg in 50mL |
| | 4 | 500 mg in 50mL |

| Medication | Option | Concentration |
|---|---|---|
| **Clonidine** | 1 | 187.5 microgram in 50 mL |
| | 2 | 375 microgram in 50 mL |
| | 3 | 750 microgram in 50mL |
| | 4 | 2000 microgram (2mg) in 50ml |
| **Dinoprostone** | 1 | 50 microgram in 50mL |
| | 2 | 200 microgram in 50mL |
| **Dobutamine** | 1 | 20 mg in 20mL |
| | 2 | 40 mg in 20mL |
| | 3 | 100 mg in 20mL |
| **Dopamine** | 1 | 20 mg in 20mL |
| | 2 | 30 mg in 20mL<br>(if available use Neoatricon ready to use product)* |
| | 3 | 90 mg in 20mL<br>(if available use Neoatricon ready to use product)* |
| | 4 | 240 mg in 20mL |
| **Fentanyl** | 1 | 250 microgram in 50mL |
| | 2 | 500 microgram in 50mL |
| | 3 | 1000 microgram (1mg) in 50mL |
| **Furosemide** | 1 | 50 mg in 50 mL |
| | 2 | 150 mg in 50 mL |
| | 3 | 250 mg in 50 mL |
| **Glucagon** | 1 | 2mg in 50 mL |
| **Heparin** | 1 | 3,750 units in 50 mL |
| | 2 | 10,000 units in 50 mL |
| **Insulin (soluble)** | 1 | 5 units in 50mL |
| | 2 | 25 units in 50 mL |
| | 3 | 50 units in 50ml |
| **Isoprenaline** | 1 | 0.2 mg in 20 mL |
| | 2 | 0.4 mg in 20 mL |
| | 3 | 1.2 mg in 20 mL |
| **Midazolam** | 1 | 12.5 mg in 50mL |
| | 2 | 25 mg in 50mL |
| | 3 | 50 mg in 50mL |
| | 4 | 100 mg in 50mL |

| Medication | Option | Concentration |
|---|---|---|
| **Milrinone** | 1 | 2mg in 20mL |
| | 2 | 20mg in 50mL |
| | 3 | 50mg in 50mL |
| **Morphine** | 1 | 1.25 mg in 50mL |
| | 2 | 2.5 mg in 50mL |
| | 3 | 10 mg in 50mL |
| | 4 | 50 mg in 50mL |
| **Noradrenaline** | 1 | 0.2 mg in 20mL |
| | 2 | 0.4 mg in 20mL |
| | 3 | 0.8 mg in 20mL |
| | 4 | 3.2 mg in 20mL |
| **Octreotide** | 1 | 100 microgram in 20 mL |
| | 2 | 200 microgram in 20 mL |
| | 3 | 1 mg in 20 mL |
| **Rocuronium** | 1 | 62.5 mg in 50mL |
| | 2 | 250 mg in 50mL |
| | 3 | 500 mg in 50mL |
| **Sildenafil** | 1 | 10 mg in 50 mL |
| | 2 | 10 mg in 12.5 mL (neat) |
| **Vecuronium** | 1 | 12.5 mg in 50 mL |
| | 2 | 50 mg in 50 mL |

*Neoatricon is a licensed ready to use formulation available in two concentrations which allow 30mg in 20mL and 90mg in 20mL concentrations in the framework to be used, without any further dilution required. Other current dopamine preparations are available which need to be used 'off-label' and also need to be diluted. Where possible a licensed product should be used.

# 3 How to use the framework

Each drug has a number of standard concentrations associated with it. Although the national framework provides suggested weight bands for each concentration, in practice any of the concentrations can be used for any patient so long as the rate in ml/hr is more than 0.1mL/hr (the minimum rate that syringe pump drivers can run at).

The framework may be amended over time if licensed ready to use formulations become available that are not in line with the current framework concentrations, but deemed still to be suitable for neonatal use.

## 3.1 Choosing an appropriate concentration

The following scenarios demonstrate how the infusion framework can be used to manage different neonatal patients, to ensure that daily fluid allowance is not exceeded and to maximise the amount of fluid available for nutrition.

### Scenario 1

A Baby of 0.6kg requires 60mL/kg/day of fluid and is prescribed the following: -

- Adrenaline 1 microgram/kg/min
- Dobutamine 20 microgram/kg/min
- Dopamine 20 microgram/kg/min
- Morphine 20 microgram/kg/hr

60mL/kg/day of fluid for 0.6kg = 36mL/day

Using the 'Option 1' infusions on the framework, this would provide the following infusion rates and fluid volume delivery per day: -

| Drug & concentration | Dose | Infusion rate | Volume per day | Volume per kg per day |
|---|---|---|---|---|
| Adrenaline **0.2** mg in **2**0mL | 1 microgram/kg/min | 3.6 mL/hr | 86.4 mL/day | 144 ml/kg/day |
| Dobutamine **20** mg/20mL | 20 microgram/kg/min | 0.72 mL/hr | 17.3 mL/day | 28.8 ml/kg/day |
| Dopamine 3**0** mg/20mL | 20 microgram/kg/min | 0.48 mL/hr | 11.5 mL/day | 19.2 ml/kg/day |
| Morphine **1.25** mg/50mL | 20 microgram/kg/hr | 0.48 mL/hr | 11.5 mL/day | 19.2 ml/kg/day |
| **TOTAL volume** | | | **126.7 mL/day** | **211.2 ml/kg/day** |

126.7 mL/day would be equivalent to 211mL/kg/day, which is significantly more than their daily fluid allowance.

Therefore to concentrate these infusions to reduce the amount of fluid that is being administered, other concentrations for each drug on the framework can be used.
Select a concentration that will appropriately reduce your rate of infusion in mL/hr, but still allow a minimum infusion rate of 0.1mL/hr to be delivered.

For this baby, the following drug concentrations could be used.

| Drug & concentration | Dose | Infusion rate | Volume per day | Volume per kg per day |
|---|---|---|---|---|
| Adrenaline 3.2 mg in 20mL | 1 microgram/kg/min | 0.23mL/hr | 5.5mL/day | 9.1 ml/kg/day |
| Dobutamine 100 mg/20mL | 20 microgram/kg/min | 0.14mL/hr | 3.4mL/day | 5.7 ml/kg/day |
| Dopamine 90 mg/20mL | 20 microgram/kg/min | 0.16mL/hr | 3.8mL/day | 6.3 ml/kg/day |
| Morphine 2.5 mg/50mL | 20 microgram/kg/hr | 0.24ml/hr | 5.8mL/day | 9.7 ml/kg/day |
| **TOTAL volume** | | | **18.5ml/day** | **30.8 ml/kg/day** |

18.5 mL/day would be equivalent to 30.8mL/kg/day, which leaves almost another 30mL/kg/day that could be used for nutrition.

## Scenario 2

A baby of 3.8kg requires 60mL/kg/day of fluid and is prescribed the following: -

- Dinoprostone 40 nanogram/kg/min
- Morphine 30microgram/kg/hr

60mL/kg/day of fluid for 3.8kg = 228mL/day

Using the 'Option 1' for dinoprostone and 'Option 2' for morphine infusions on the framework, this would provide the following infusion rates and fluid volume delivery per day: -

| Drug & concentration | Dose | Infusion rate | Volume per day | Volume per kg per day |
|---|---|---|---|---|
| **Dinoprostone 50 microgram/50mL** | 40 nanogram/kg/min | 9.12mL/hr | 218.9mL/day | 57.6 ml/kg/day |
| **Morphine 2.5 mg/50mL** | 30 microgram/kg/hr | 2.28mL/hr | 54.7 mL/day | 14.4 ml/kg/day |
| **TOTAL volume** | | | **273.6 mL/day** | **72 ml/kg/day** |

273.6 mL/day would be equivalent to 72 mL/kg/day, which is more than their daily fluid allowance.

Therefore, to concentrate these infusions to reduce the amount of fluid that is being administered, other concentrations for each drug on the framework can be used.
Select a concentration that will appropriately reduce your rate of infusion in mL/hr, but still allow a minimum infusion rate of 0.1mL/hr to be delivered.

**Option 1**
For this baby, the following drug concentrations could be used.

| Drug & concentration | Dose | Infusion rate | Volume per day | Volume per kg per day |
|---|---|---|---|---|
| **Dinoprostone 200 microgram/50mL** | 40 nanogram/kg/min | 2.28mL/hr | 54.7mL/day | 14.4 ml/kg/day |
| **Morphine 50 mg/50mL** | 30 microgram/kg/hr | 0.11mL/hr | 2.6 mL/day | 0.68 ml/kg/day |
| **TOTAL volume** | | | **57.3 mL/day** | **15.1 ml/kg/day** |

57.3 mL/day would be equivalent to 15.1mL/kg/day, which leaves almost another 45mL/kg/day that could be used for nutrition.

**Option 2**
For this baby, the following drug concentrations could be used, with a less concentrated morphine infusion than in option1)

| Drug & concentration | Dose | Infusion rate | Volume per day | Volume per kg per day |
|---|---|---|---|---|
| **Dinoprostone 200 microgram/50mL** | 40 nanogram/kg/min | 2.28mL/hr | 54.7mL/day | 14.4 ml/kg/day |
| **Morphine 10mg/50mL** | 30 microgram/kg/hr | 0.57mL/hr | 13.7 mL/day | 3.6 ml/kg/day |
| **TOTAL volume** | | | **68.4 mL/day** | **18 ml/kg/day** |

68.4 mL/day would be equivalent to 18mL/kg/day, which leaves almost another 42mL/kg/day that could be used for nutrition.

### 3.2 Use of the electronic calculator to calculate which infusion concentration to use.

East of England ODN have developed a calculator tool to help staff calculate the impact of choosing a particular drug concentration on the fluid allowance for a baby.
This tool allows the user to enter details of the weight of the baby and the current fluid allowance per day. The user can then select specific drug(s), enter the dose required and change the concentration to see what impact this has on the rate in ml/hr of drug that would be infused and also the impact on the daily fluid allowance.

The ODN Lead Pharmacist will maintain this calculator and a version control record.

# 4 Drug Infusion Pump libraries

The following syringe driver pumps are used in neonatal units in East of England
- Alaris Nexus CC
- Alaris CC Plus
- Alaris Asena CC
- Baxter EvoIQ SYR
- BBraun Perfusor Space
- BBraun Perfusor Space Plus
- Fresenius Kabi Agilia SP MC

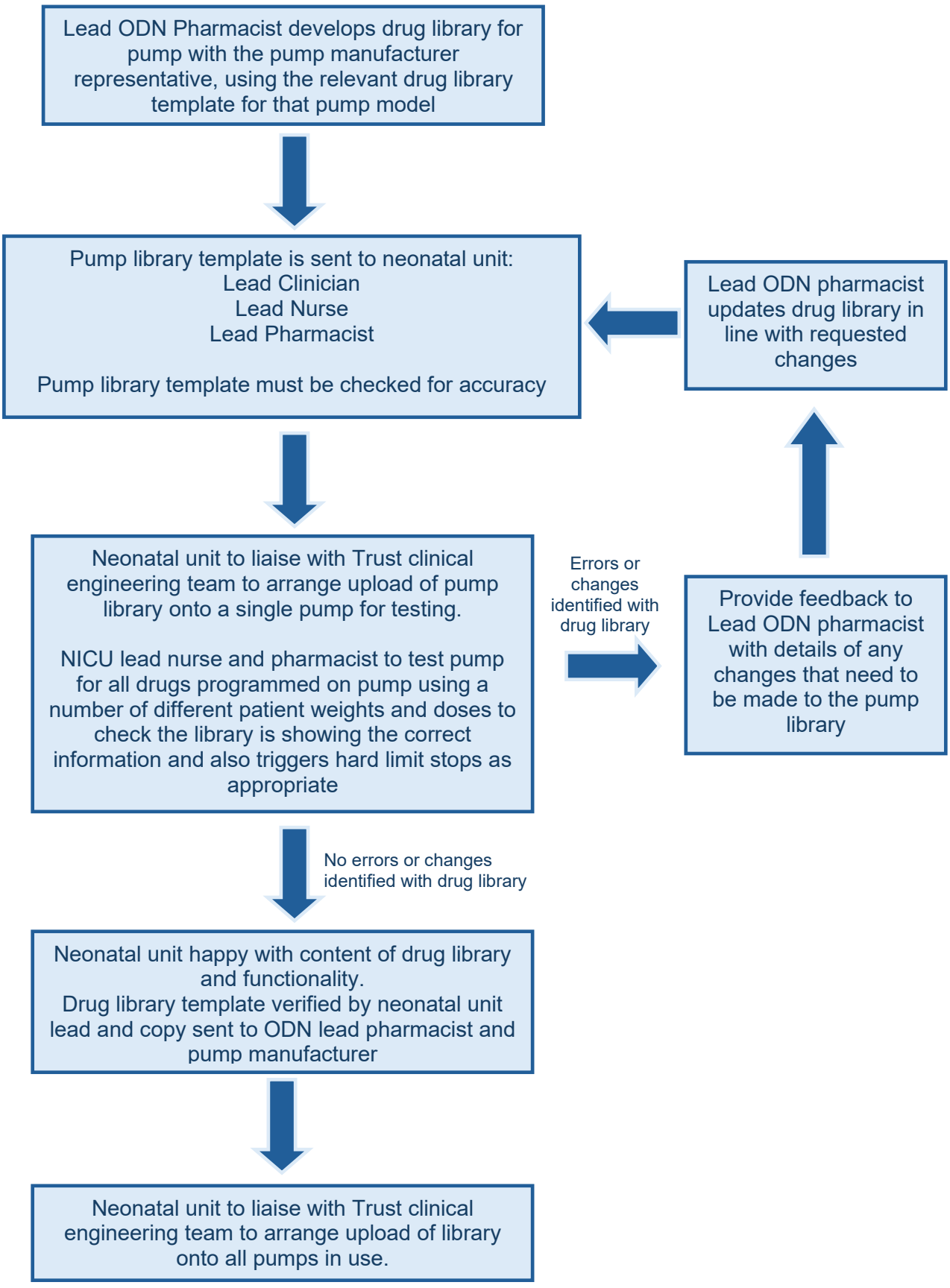
A comprehensive drug library is critical for the effective and safe use of any ‘smart’ infusion system. If smart pumps can also be integrated with EPMA systems then this also provides additional safety functionality. However ‘smart’ pumps that are not integrated with EPMA will still provide a high amount of safety.

The ODN Lead pharmacist will work with representatives of the pump manufacturers to develop a drug library based on the standard infusion framework for each model of pump in use.

Once a drug library has been developed it will be sent to the lead nurse, lead clinician and lead pharmacist for the neonatal unit in each Trust, so that they can liaise with their clinical engineering team regarding uploading a test version onto a pump for testing and validation. Any changes identified must be fed back to the ODN Lead Pharmacist, who will liaise with the pump manufacturer representative to update the drug library template. The new template must then be retested by the neonatal centre until they are happy and can sign off the library. Once the drug library is validated, then the unit will liaise with their clinical engineering team to ensure the drug library has been uploaded onto all pumps that are in use.
Training of staff using the drug library will initially be undertaken by the pump manufacturer representatives.

Pump libraries will also allow specific parameters regarding infusion pressure limits to be set to reduce risk of extravasation injuries

## 4.1 Process for development and validation of Infusion Pump drug libraries



# 5 Minimising inconsistent drug delivery via continuous infusion in neonates

Guidance around minimising inconsistency in drug delivery of continuous infusions in neonates has been issued by BAPM/NPPG in a position statement[2].

There is evidence that drug delivery via continuous intravenous infusion can be inconsistent when:

- administered at low flow rates (≤0.5mL/hr)
- there is a change in syringe pump height relative to the patient's position

These effects, which are likely to be clinically significant with a number of short half-life medicines used in neonatal practice, are more pronounced when drug infusions are prepared in 50mL syringes rather than 20mL or 30mL syringes.

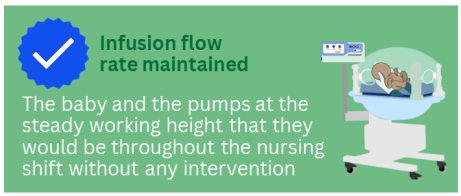
Recommendations

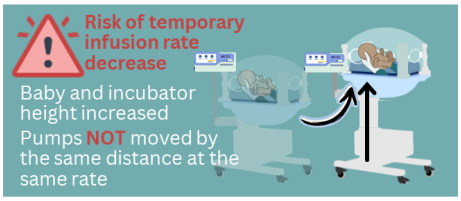
1) The following medicines, used in neonatal practice should be administered from 20mL or 30mL syringes to minimise inconsistent delivery at low infusion rates:

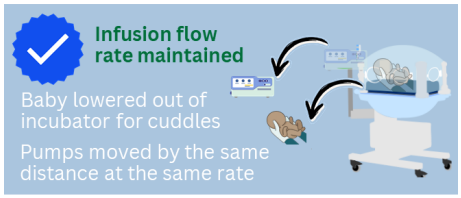
   - Adrenaline
   - Dobutamine
   - Dopamine
   - Isoprenaline
   - Noradrenaline
   - Argipressin (Vasopressin)

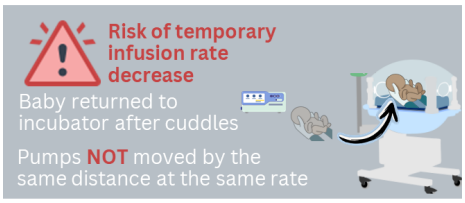
2) Be aware that for short half-life drugs (listed above), changing the height of the syringe, relative to the position of the baby can cause a sudden change in drug delivery.

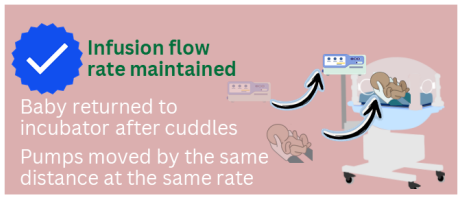
3) Where possible try to move syringe pumps in line with the patient, if either need to be moved - see Appendix 1 for further guidance.

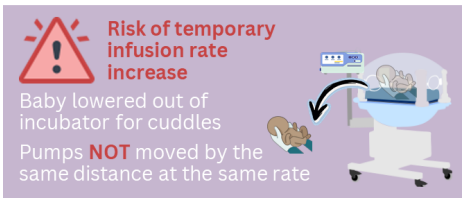



# 6 Parenteral monographs for preparation of drug infusions.

The East of England neonatal ODN publishes standard neonatal drug infusion monographs for use of parenteral medication. These monographs are hosted by the national Medusa Injectable Medicines website and each EoE Trust has its own log in access to the website.

The monographs are maintained by the East of England ODN lead neonatal pharmacist and are updated on a rolling programme.

# References

1. NPPG/RCPCH/BAPM/PCCS. Standardising intravenous infusion concentrations for neonates and children in the UK. Nov 2024. https://nppg.org.uk/standardised-infusions/
2. NPPG/BAPM/NNA. Minimising inconsistent drug delivery via continuous intravenous infusion in neonates. Nov 2024 https://nppg.org.uk/neonatal-infusion-position-statement/

# Appendix 1 – moving syringe pumps relative to the height of the baby

Key considerations for implementation from the perspectives of staff, families and the patient are given below.

**Guidance for Implementation**

Staff Education and Support

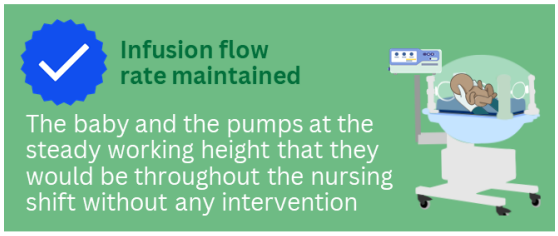
- Staff should receive education on short half-life drug infusions to understand the requirement for caution if needing to move syringe pumps or patients.
- Manual handling training should incorporate:
  - Movement of syringe pumps in line with the patient when the baby is coming out of the incubator
  - Appropriate movement of equipment and pumps together to ensure that the incubator/cot is height appropriate for the user to avoid stooping or overstretching resulting in injury or poor posture when, for example, providing cares or inserting lines.
  - Safe and appropriate placement of pumps which need to be moved in line with the patient.
- When new equipment is purchased, incubators with integrated pump docking should be considered.
- Where a baby is on short half-life infusions, the potential for unreliable flow on vertical movement of patient/pump should be discussed and documented as part of MDT ward rounds and handovers.

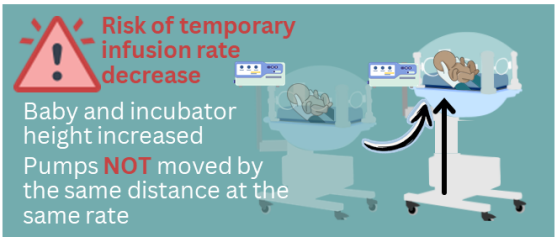
Families

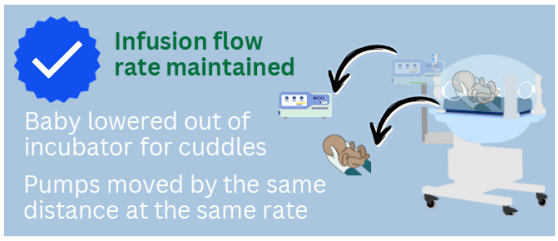
- The need for cautious movement of short half-life drug infusions should not be detrimental to Family Integrated (FI) Care. FI Care improves parental well-being reducing stress and anxiety.
- Families should continue to be essential carers rather than visitors, with unrestricted access to their baby, to reduce the potential neurodevelopment and attachment consequences of restrictions.
- Parents should be educated on short half-life drug infusions, allowing them to seek support when adjusting the height of the incubator to care for their baby.
- The need for cautious movement of short half-life drug infusions should not be a barrier to skin to skin contact.
  - If a baby is considered too unstable to be moved, the family should be supported with alternative positive touch.

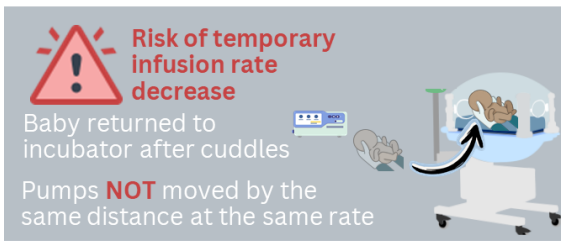
Patient

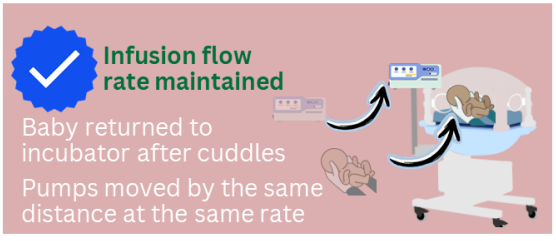
- Care should not be disrupted or delayed due to the requirement for short half-life drug infusions.
- Short half-life infusions should be easily identifiable.
- Patients should be on appropriate continuous monitoring.

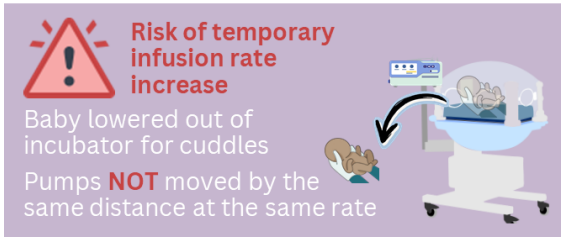


# Exceptional Circumstances Form

Form to be completed in the **exceptional** circumstances that the Trust is not able to follow ODN approved guidelines.

| Details of person completing the form: | |
|---|---|
| Title: | Organisation: |
| First name: | Email contact address: |
| Surname: | Telephone contact number: |
| Title of document to be excepted from: | |
| Rationale why Trust is unable to adhere to the document: | |
| Signature of speciality Clinical Lead:<br><br>Date: | Signature of Trust Nursing / Medical Director:<br><br>Date: |
| Hard Copy Received by ODN (date and sign): | Date acknowledgement receipt sent out: |

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