Standard Operating Procedure for Use of the Children's Health Ireland Paediatric Smart-Pump Drug Library	
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Read in conjunction with:	Site-Specific Medication Policy CHI Paediatric Formulary CHI Standard Concentration Infusion Tables *(area-specific version)*

Contents

Abbreviation Index

ANTT	Antiseptic Non-Touch Technique
CHI	Children's Health Ireland
CNEF	Clinical Nurse Education Facilitator (may be referred to locally as CNF/CEF)
CNM	Clinical Nurse Manager
CVAD	Central Venous Access Device
DERS	Dose Error Reduction Software
ED	Emergency Department
HCRN	Health Care Record Number
ICCA®	IntelliSpace Critical Care & Anesthesia Clinical Information Management System
IV	Intravenous
KVO	Keep Vein Open
NB	Nota Bene (note well)
NMBI	Nursing And Midwifery Board of Ireland
OLCHC	Our Lady's Children's Hospital, Crumlin (former title of CHI at Crumlin)
PRN	Pro Re Nata (as required)
SCI	Standard Concentration Infusion
SOP	Standard Operating Procedure
TPN	Total Parenteral Nutrition
UCC	Urgent Care Centre
VTBI	Volume To Be Infused

1. Introduction

The aim of this standard operating procedure (SOP) is to guide staff of Children's Health Ireland (CHI) in the preparation and administration of intravenous medications as Standard Concentration Infusions (SCIs) via the CHI smart-pump drug library. While this document refers to CHI resources, it may be a useful tool in assisting users in non-CHI sites in use of the CHI smart-pump drug library implemented as part of the National Paediatric and Neonatal Smart-pump Project.

Smart-pumps are computerised infusion devices using 'dose error reduction software' (DERS) which allows uploading of a drug library with pre-set dosing limits. They have been shown to increase the safety of intravenous (IV) medication administration, with compliance in use of the drug library central to effective error prevention (Ohashi et al., 2014). Best practice guidelines from the Institute for Safe Medication Practices (2020) recommend the use of standardised concentration infusions (SCIs) and smart-pumps with DERS for all high-risk medications in all clinical cares, including where a loading or bolus medication dose is given.

2. General Principles for Use of the CHI Smart-Pump Drug Library

2.1. The CHI smart-pump drug library ("the drug library") is available for use on B.Braun Perfusor® Space or Infusomat® Space smart-pumps across CHI sites.

2.2. A valid prescription (paper or electronic) must be available and checked prior to administration of any medication. The recommended reference for checking dosing and administration information is the CHI Formulary; if an alternative reference source is being used, appropriate care should be used to ensure the information provided is aligned with use of the CHI drug library.

2.3. Where accommodated, all IV medication infusions must be administered via the drug library. Note: CHI Medication Policies are currently being updated to reflect this. Exceptions include medications suitable for manual administration directly into an IV cannula as a slow bolus. Some medications have additional restrictions. Staff should familiarise themselves with their local policy.

2.4. Where a medication is not accommodated in the drug library, the B.Braun Space® pumps should continue to be used, but ***without*** use of the drug library i.e. the medication should be given 'off-library'. In exceptional circumstances, a 'custom concentration' which differs from the drug library may be programmed using the pump 'Special functions' option– this process may only occur under the direction of a consultant and must be programmed by a senior doctor experienced in use of the B.Braun Space® pumps. Nursing staff must ***never programme*** a 'custom concentration'.

2.5. The drug library may only be used by nurses who have successfully completed smart-pump training and drug library training and are working within an area which has been formally approved for smart-pump drug library use by the CHI smart-pump team. Further detail on the CHI smart-pump training can be found in Appendix 9: CHI Smart-Pump Training Exercises and Assessment. To administer a standard concentration infusion, nurses must also have attended CHI medication safety management and IV therapy management study day(s) and completed associated competencies as per local requirements to provide them with relevant medication administration rights.

2.6. Drug library training is provided by approved CHI nursing staff under the supervision of the CHI smart-pump clinical nurse education facilitator. Local CNEFs/CNMs should keep a record of staff trained in their respective area; this record should be forwarded to the CHI smart-pump team to ensure a complete CHI-wide training record is maintained. Note: **User-trainers** can train staff in how to use the drug library; they cannot train staff in how to train users of the drug library. **Train-the-trainers** can train staff in how to use the drug library and can also train other staff to train users of the drug library. User-trainers and trainer-trainers must be approved and have their trainer status confirmed by the CHI smart-pump team.

2.7. The drug library contains a number of different **'care units'** allowing the list of medications offered to be tailored to particular patient cohorts e.g. PICU/Theatre. Staff must be vigilant to ensure the appropriate care unit is in use, particularly during transition of care within and between CHI sites. Note: All care units are not available on every pump within CHI currently – pumps should not be swapped across CHI sites without consulting the clinical engineering department(s) and the CHI smart-pump team.

2.8. A number of non-CHI sites are also currently using CHI-developed specific care units tailored to their setting e.g. neonatal units in maternity hospitals, regional adult centres. B.Braun Space pumps should *not* be 'swapped' with any other site, including within the same hospital group. In the event of a pump 'swap', sites may inadvertently have access to medications not approved for use in their site *or* users may not be able to access the full range of medications required in their setting.

2.9. Full details of the included medications, and associated standard concentrations, are available as care unit-specific SCI Tables. See Appendix 1: Standard Concentration Infusion Tables. SCI tables, as referred throughout this document, can be found on: each respective site's intranet (or QPulse document repository); in printed form (*limited to certain wards/areas only*); and on ward tablets held in medication treatment rooms and on certain medication trolleys (certain CHI sites only). This table is subject to changes and updates - care should be taken to ensure the most current version is being referenced. A project is currently underway to include a shortened medication-specific SCI table within the administration section of individual monographs in the CHI formulary.

2.10. To minimise the risk of medication error, a two-nurse independent double check procedure should be employed for **medication preparation** and **smart-pump programming** for all: continuous infusions, non-continuous infusions, dose changes and bolus medication doses. All medication preparation and pump programming should be signed by the two nurses who completed each respective step (exceptions: medications administered by a doctor should be signed for by the person administering it; bolus administration under certain circumstances in PICU – see Appendix 3: Management of SCIs in PICU.

2.11. The CHI Smart-pump team, based in CHI at Crumlin, can be contacted on 01-4096696 (Bleep 8813) or directly via any of the individual team members – see Table 1 below.

Table 1: CHI Smart-Pump Team

Name	**Role**	**Contact**
Moninne Howlett	Chief Pharmacy Information Officer, CHI – Pharmacy Lead	moninne.howlett@olchc.ie
Cormac Breatnach	Consultant Paediatric Intensivist – Clinical Lead	cormac.breatnach@olchc.ie
Eimear McGrath	Clinical Nurse Education Facilitator (Smart-Pumps)	eimear.mcgrath@olchc.ie
Sharon Sutton	Senior Pharmacist (Smart-Pumps)	sharon.sutton@olchc.ie
Drug library users located across any of the CHI sites can also contact the CHI Smart Pump Support Nurse (CNM1) at 087 373 0966, Crumlin bleep 8813 or pump.training@olchc.ie		

3. Preparation of a Standard Concentration Infusion

3.1. Confirm that the prescribed IV dose and medication is appropriate for the patient

3.2. Refer to the appropriate SCI table to ascertain the correct SCI to be prepared. These tables are available in the CHI Formulary, CHI Intranets and Q Pulse document repository, ward tablets *(certain areas in some CHI sites only)* and hard copies on wards.

Note: Separate tables are available for:

- Continuous Infusions (and associated loading doses)
- Non-Continuous Infusions

See Appendix 1: Standard Concentration Infusion Tables for further guidance on use of SCI tables

3.3. For all continuous infusions (including those where a loading dose is prescribed), confirm the following are correct according to the patient's weight band on the SCI Table (See Figure 1):

- Amount of medication to be added to infusion
- Amount of diluent to be added to infusion
- Final volume in syringe

CONTINUOUS INFUSIONS & LOADING DOSES EMERGENCY DEPARTMENTS, WARDS AND DAY UNITS (excludes PICU and Theatre)					Rate Calc (mL/hour) =	Required Dose x Default Rate (ml/hour) / Default Start Dose	
Drug	Category	Weight Band	Standard Concentration Infusion (SCI)	Diluent	Usual Dose Range	Default Dose and Rate Calculator *All Weights in kg - rounding can occur*	
						Default Start Dose	Default Rate (mL/hr)
Adrenaline	Cardio	All ≤5kg >5 - ≤10kg All >10kg	1mg/50mL 3mg/50mL 6mg/50mL	Glucose 5%w/v NaCl 0.9%w/v Glucose 10%w/v	0 -0.1microgram/kg/min	0.05microgram/kg/min	0.15 x Wt 0.05 x Wt 0.025 x Wt

Figure 1: Example of SCI Table - Continuous Infusion

3.4. For all non-continuous infusions, determine the final concentration for the dose to be prepared as per the patient's weight band on the SCI table (See Figure 2).

NON-CONTINUOUS INFUSIONS EMERGENCY DEPARTMENTS, WARDS AND DAY UNITS (excludes PICU and Theatre)						Final Infusion Volume = Total prescribed dose / Value in SCI column (mL)	
Drug	Pump Category	Weight Band	Standard Concentration Infusion (SCI)	Diluent	Usual Dose Range and Time +/- Frequency	Default Dose	VTBI (mL) All Weights in kg
Aciclovir	Antimicrobial	All	5mg/mL	Glucose 5%w/v NaCl 0.9%w/v	10-20mg/kg over 1 hour	None	Variable

Figure 2: Example of SCI Table - Non-Continuous Example

Note on Reconstitution:

Some medications will be available pre-prepared and are withdrawn directly from a vial or bag (e.g. Paracetamol, Esmolol, Potassium Chloride 0.2mmol/mL) while others will need to be diluted (e.g. Morphine, Adrenaline) or reconstituted (e.g. Vancomycin). Please refer to the CHI Formulary for details of available preparations, including displacement values for medications requiring re-constitution.

Note on IV Access Device Available:

Some medications have a concentration (SCI) that is only suitable for infusion via a Central Venous Access Device (CVAD). Ensure these SCIs are only selected where the patient has a CVAD.

Note when Preparing Loading Dose Infusions:

The SCI of a loading dose and its corresponding continuous infusion is always the same. A single infusion solution (syringe/bag) should be prepared to deliver both the loading dose and the subsequent infusion. N.B: a separate syringe/bag does not need to be prepared following administration of the loading dose.

Note when Preparing Non-Continuous Infusions:

The SCI stated on the Non-Continuous table indicates the final concentration of the infusion. This final concentration value should be noted in advance of preparation and the final volume in the syringe/bag should contain this concentration only. Any additional or insufficient dilution will prevent the user from administering the correct volume via the drug library.

Note on Choice of Container for Preparation of Non-continuous Infusions:

The container for preparation of non-continuous infusions should be chosen with due consideration of the final VTBI:

- ≤ 50mL/60mL* – an appropriately sized syringe
- > 50mL/60mL* and ≤ 150mL# – a buretrol
- >150mL# and ≤ 250mL – an empty sterile bag (see Appendix 6: Preparation of SCI Infusions using Empty Sterile Bags)
- Where the above options are not suitable, infusions can be prepared in pre-filled IV fluid bags; see
- Appendix 7: Preparation of Standard Concentration Infusions using IV Fluid Bags to ensure correct preparation

**Total capacity of B.Braun 50mL syringe is 50mL, whereas BD 50mL syringe has a total capacity of 60mL (as indicated on the product). When using a BD 50mL syringe, a volume of up to 60mL may continue to be used in the B.Braun Perfusor® Space pump.*

#or equivalent maximum capacity of buretrol available

Note on Choice of Giving Set for Administration of Non-Continuous Infusions:

Careful selection of syringe giving sets is required to ensure that the giving set volume is less than the final volume to be infused. Example: Amoxicillin total dose 45mg; SCI 50mg/mL; VTBI 0.9mL. If the giving set priming volume is greater than this volume, the medication will not fill the length of the line.

A low volume giving set (0.3mL priming volume) should be stocked to ensure that users can delivery all drug-library infusions at the correct volume. Further details can be found in

Appendix 8: Preparation of Small Volume Infusions requiring 0.3mL Giving Sets.

3.5. Prepare all the equipment required for reconstitution of the infusion, maintaining local sterile/ANTT standards throughout preparation to prevent contamination and reduce the risk of infection.

3.6. Complete the appropriate infusion label with the following information, using a medication-specific label where available:

- Patient's Name
- Weight
- Date of Birth
- Health Care Record Number (HCRN)
- Name of medication to be added
- Amount of medication to be added
- Name and concentration of diluent
- Final volume in syringe
- Date and time of preparation of the infusion
- Signature of both nurses who have checked and will prepare the order

3.7. Both nurses independently calculate the volume of the medication and diluent to be drawn up according to the correct standard concentration.

Figure 2: Example of Preparation of Continuous Infusion

Patient weight: 25kg
Medication order: Adrenaline 6mg/50mL in Glucose 5%

Adrenaline vial contains 1mg/mL*
Volume of Adrenaline to be withdrawn from vial:
$\frac{6mg \times 1mL}{1mg}$ = **6mL**
……..
Volume of diluent required to achieve a total final volume of 50mL:
50mL (total volume) – 6mL Adrenaline = **44mL** of Glucose 5%

Add **6mL** (Adrenaline) to **44mL** (diluent) to achieve Adrenaline 6mg/50mL in Glucose 5%

**preparation available from CHI at Crumlin and Temple Street pharmacy departments as of July 2020*

Figure 3: Example of Preparation of Non-Continuous Infusion

Patient weight: 22kg
Medication order: Aciclovir 220mg (equivalent to 10mg/kg)

SCI for Aciclovir: **5mg/mL** (see SCI table example on page 6)

Aciclovir vial contains 250mg/10mL*
Volume of Aciclovir (250mg/10mL) to be withdrawn from vial: [(220mg ÷ 250mg) x 10mL] = **8.8mL**

Final VTBI: Total dose ÷ **SCI**
= 220mg ÷ **5mg/mL**
= **44mL**

Volume of diluent: (Total VTBI – Volume of Aciclovir) = **44mL** - **8.8mL** = **35.2mL**

Add **8.8mL** (Aciclovir) to **35.2mL** (diluent) to achieve VTBI of **44mL** Aciclovir
Final 44mL of solution contains Aciclovir 220mg as a 5mg/mL solution

**preparation available from CHI at Crumlin and Temple Street pharmacy departments as of July 2020*

3.8. Draw up the calculated volume of the prescribed medication and diluent (where applicable) as two separate solutions. See note on reconstitution in 3.4 above. If preparation is neat, skip to 3.10 below.

3.9. Add the medication to the diluent, inverting the syringe/bag several times to mix sufficiently.

3.10. Attach the prepared label ensuring it will be clearly visible once the syringe/bag is connected/loaded into the pump.

3.11. Attach the appropriate IV giving set and manually prime the infusion to the end of the line. See note on choice of giving set for administration of non-continuous infusions under 3.4 above.

For syringes: Do not close the clamp as this can damage the line.

3.12. Document and sign/co-sign the preparation of the infusion on the medication order.

3.13. Dispose of sharps and waste as per hospital waste policy.

4. Features of the Paediatric Standard Concentration Infusion Drug Library

4.1. Pump Selection

The Perfusor® pump is programmed to accept syringes of 50mL capacity and below (minimum 2mL; 1mL syringes are not accepted).The Infusomat® pump will accept a giving set which can be attached to any volume infusion bag. The drug library is available on both Perfusor® (syringe driver) and Infusomat® (large volume) pumps; only those drug lines applicable to each pump type will display. As pump programming occurs following preparation of infusion, the final infusion volume will indicate which pump to use. For example, if the volume to be infused is 180mL, this will be given via an Infusomat® pump and therefore may not be available on the Perfusor® drug library.

4.2. Syringe Selection

When a syringe is inserted into the pump, the user is presented with a list of syringe options from which to select the syringe in use. Different brands/models of syringe may vary in barrel diameter, even with corresponding volume capacity. It is important to select the correct syringe as the pump will deliver the infusion at the appropriate rate for the specific syringe selected.

Please see Appendix 5: Maximum Flow Rates on B.Braun Perfusor® Pumps if the pump displays a syringe selection error during pump programming.

N.B: syringe selection errors can result in the pump delivering incorrect volume and therefore incorrect dose.

4.3. Line Priming

Priming a giving set ensures that the medication has reached the tip of the line, removing any air bubbles and preventing a delay in delivery of medication. Lines can be manually primed following infusion preparation; the pump may also offer a line prime following syringe/line insertion.

*To stop line prime, press '**OK**' button*

For non-continuous infusions, containing a specific 'volume to be infused' (VTBI), it is recommended to manually prime the line to ensure that no volume of medication to be infused is discarded by the pump prime.

For continuous infusions, particularly those that will be infusing at low infusion rates and/or via gangs e.g. inotropes, priming the line via the pump allows pressure to build up within the pump. *Note*: On B.Braun Perfusor® pumps, pressure build is automatic once the syringe clamp is engaged and line has been primed. As a consequence, it is not necessary to run infusions at low rates to maintain pressures prior to connecting to the patient and commencing an infusion.

To prime a line when an infusion has already been programmed:

- Stop the infusion
- Disconnect the giving set from the patient
- Press the '**BOL'** (Bolus function) button
- Screen will display **Prime Line?** '**Yes**' or '**No**'; select by pressing '▲' or '▼' arrow as appropriate.

NB: to access the priming option the infusion must be stopped. If the programme isn't stopped, the bolus button will offer a bolus medication dose (where available) or an 'invalid' warning.

4.4. **Care Units**

There are six separate care units within the CHI (Version 4) Drug Library:

Emergency Departments/Wards/Day Units *[currently named 'Emergency Department' (Crumlin and Temple Street or 'UCC Main Library' (Connolly and Tallaght)]*
PICU/Theatre
Children's Heart Centre (CHC)*
CVVH (Continuous Veno-Venous Hemofiltration)
ECLS (Extracorporeal Life Support)
Metabolic Agents*

** Care unit likely to be removed on the CHI (Version 5) Drug Library due to be implemented Q1 2021.*

Each care unit contains a different range of 'drug lines' and associated concentrations. The care unit selected will be visible at the top of the screen once the patient's weight band is selected, and at the bottom of the screen once an infusion is running. To access and change care units, scroll to the bottom of any menu screen to select 'Change care unit'.

4.5. **Weight Bands**

There are five weight bands available on the pump: 0 up to 2.5kg, >2.5kg up to 5kg, >5kg up to 10kg, >10kg up to 20kg and >20kg. The weight band to be selected is determined by the patient's weight (as stated on the patient's prescription)

4.6. **Therapeutic Categories**

All medications can be found in both 'All drugs' and within one of seven therapeutic categories: Antimicrobials, Cardiovascular, Central Nervous System, Endocrine/GI, Fluids/Electrolytes/Nutrition, Haematology and Respiratory (exception: Acetylcysteine and flushes are only in 'All drugs'). An index list of medications and therapeutic categories can be found alongside the SCI tables.

4.7. **Non-Weight-Based Dosing**

A number of medications are offered a weight-based dose ('Paediatric') and a non-weight-based dose ('Usual Adult dose') option. This is to prevent patients from receiving a dose of medication that is higher than a standard adult dose. This is most common in the >20kg weight band and for non-continuous medications, however a small number of continuous medications also have this option e.g. Salbutamol, Isoprenaline, Liothyronine. Where a weight-based and non-weight-based, or a loading and maintenance option are offered, ensure the correct 'drug line' is selected. Non-weight-based dosing is <u>not</u> stated as a dose per kilogram, but rather in total dose e.g. mg.

4.8. **Infusion Strength**

In the paediatric ED/Ward/Day Unit Care Unit, a small number of medications are offered **two concentrations**: Aciclovir, Calcium Gluconate, Co-Trimoxazole, Gentamicin, Tranexamic Acid, and Vancomycin. This is offered as a separate 'drug line'.

In the PICU/Theatre Care Unit most continuous infusions have both a standard and a high-strength concentration offered within each weight band.

Where the high strength concentration is required, it is essential to be vigilant when selecting the drug concentration required to ensure correct volumes will be delivered to the patient and patient safety is maintained.

Exceptions: Some medications have a range of standard concentrations that do not fall into the five weight bands e.g. Epoprostenol (Flolan®) has up to four offered concentrations.

NB: Some high strength medications should only be administered via a CVC; this is stated on SCI table and pump where relevant. Some high strength medications are only available in PICU/Theatre care units and will not be offered outside of these areas.

4.9. Loading Doses

Some medications require a loading dose prior to administration of a maintenance infusion. In this instance two different options are provided for:

- A separate loading 'drug line' is included in the drug library which can be programmed and delivered independently from the associated continuous/maintenance infusion.

  OR (less commonly)

- A non-mandatory load is offered at the beginning of the continuous/maintenance infusion e.g. Liothyronine, Tranexamic Acid Continuous.

Please see Section 5:

Accessing and Navigating the SCI Drug Library for instructions on how to administer a prescribed loading dose.

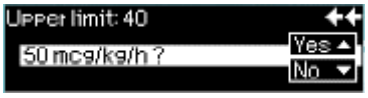
4.10. Hard and Soft Limits

These are limits which have been put in place as additional drug library safety tools.

A hard limit cannot be exceeded and is designed to prevent inadvertent programming of inappropriate doses. The pump will notify the programmer that the upper limit has been exceeded and will prevent it from being delivered.

Hard limit notification

A soft limit is set at the upper/lower end of the normal dose range for each medication and highlights that a dose outside of normal ranges is being programmed/used. When the programmer exceeds the normal dose range, they will see the pre-set soft limit above the dose being set.



Soft limit notification

The soft limit warning will be displayed and the programmer will be asked to confirm that they want to exceed the soft limit.

Soft limit symbol will display throughout infusion

4.11 Pressure Sensitivity Settings

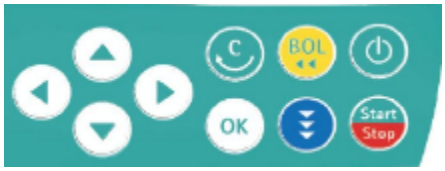
Once a medication has been programmed, the pressure (occlusion) sensitivity setting on the pump can be adjusted in the main menu under 'options'. A setting of one indicates the highest sensitivity and will trigger an occlusion alarm within the quickest time, while 9 indicates the lowest alarm sensitivity. Note: 1Fr lines (e.g. PICC) which run at very high pressures due to the narrow bore of the line may need to have higher (less

sensitive) settings of up to 9 (900mmHg) to avoid excessive alarming of the pumps and subsequent interruption of infusion delivery.

5. Accessing and Navigating the SCI Drug Library

Infusions ≤ 50mL* = Perfusor® pump

Infusions > 50mL* = Infusomat® pump



** These volumes refer to areas/sites using B.Braun syringes. In areas/sites where a BD 50mL syringe is in use, it should be noted that the total capacity of this syringe is 60mL (as indicated on the product) and that this volume capacity can continue to be used in the B.Braun Perfusor® Space pump.*

5.1. Use the buttons to the right of the pump screen to make selections for programming a pump:

- Use the '▲▼◄►' arrows to scroll through all menus/options
- When the desired option is highlighted, press the '**OK**' button to select
- Press the '**C**' button to: review the current programme, clear the current program (confirmation will be requested), return to previous screen, or cancel a selection
- Press the '**BOL**' yellow bolus button to access bolus administration programming within a continuous infusion *or* to prime the giving set when an infusion is *not* running.

5.2. Turn on pump and load syringe/line - do not connect infusion to patient yet.

Infusomat® only: keep giving set clamp closed until instructed to open on screen.

5.3. *Infusomat®*: Confirm line selection and skip to 5.5 below

or

Perfusor®: Confirm syringe type/volume. **NB**: see 4.1 for note on Pump Selection

5.4. *Perfusor® only:* Screen will display **Prime Line?** '**Yes**' or '**No**'; select by pressing '▲' or '▼' arrow as appropriate.

NB: see 4.3 for note on Line Priming

5.5. Screen will display **Use Drug Library?** '**Yes**' or '**No**'; confirm '**Yes**'.

5.6. Scroll to access **Change Care Unit** to confirm that the correct care unit is being used - this will ensure that the appropriate medications are being offered.

Note: Care units can be accessed in the above manner when viewing weight bands, therapeutic categories and drug lines.

5.7. Screen will display menu options one at a time. Scroll through each menu to select the appropriate:

- Weight Band
  ↓
- Therapeutic Category
  ↓

- Medication
  ↓
- +/- Infusion Strength (if more than one strength is offered – see 4.8)

Note: the '◄►' arrows may also be used to short-cut through a list in alphabetical groups (ABD, DEF etc) where applicable.

5.8. If presented with a caution or medicines information note: read and press the '◄' arrow or the '**OK**' button to acknowledge and continue with programming if desired.

5.9. Key in the patient's working weight using the '▲' or '▼' arrow (up to 2 decimal places) and confirm by pressing the '**OK**' button.

On completion of the above steps, to complete pump programming either Section 6: Programming a Continuous Infusion or Section 7: Programming a Loading Dose or other Non-Continuous Infusion should be referred to.

6. Programming a Continuous Infusion

There are pre-set dosing limits to prevent the programming of doses outside of safe dose ranges. Care in programming is required to ensure the correct and appropriate dose is administered.

6.1. Refer to Section 5 and follow steps 5.1-5.8.

The pump will then display the following information (scroll down to view more parameters):

- Medication Name
- Dose (default start dose)
- Concentration
- Weight (kg)
- Rate (mL/hour)
- VTBI
- Time (length of infusion)

Perfusor® smart-pump display screen with default dose

6.2. If the prescribed dose is different to the default dose, access dose by pressing the '◄' arrow, adjust the dose as per prescription and confirm by pressing the '**OK**' button.

NB: See 4.10 for note on pre-set hard and soft dosing limits

6.3. Review all pump settings.

6.4. Attach the giving set to appropriate IV access device to commence delivery of medication to patient.

NB: Where there is a delay in attaching the infusion to the patient, consider re-priming the line directly before connecting to the patient (see note on Line Priming).

6.5. Commence infusion by pressing 'START' key.

6.6. Document and sign/co-sign for pump programming.

6.7. Record dose/volume administered as per policy.

Dose Changes: Where a dose change is required during an ongoing infusion, follow 6.2 above. Dose changes should be checked by two registered nurses against the prescription. Dose and pump changes should be signed for by each nurse. **NB**: The pump does not need to be stopped to change dose.

Rate Calculation: A manual calculation of rate (mL/hour) may be performed where further verification of the infusion flow rate is required. See Appendix 2: Manual Rate Calculations for Continuous Infusions for further instructions.

7. Programming a Loading Dose or other Non-Continuous Infusion

There are pre-set dosing limits to prevent the programming of doses outside of safe dose ranges. Care in programming is required to ensure the correct and appropriate dose is administered.

7.1. Refer to Section 5 and follow steps 5.1-5.8.

7.2. When the 'Tot. dose' is displayed, key in the prescribed total dose using the arrow buttons and confirm by pressing the 'OK' button. Note: This step will be omitted where a default dose is pre-set for that drug line; in this instance the default dose will automatically be programmed but can be altered as per 7.4 below.

NB: See 4.10 for note on hard and soft dosing limits pre-programmed into the pump

7.3. When '**Time'** is displayed, key in the prescribed/desired time to administer the infusion over using the arrow buttons and confirm by pressing the '**OK**' button. Note: This step will be omitted where a default 'time' to infuse over (TTIO) is pre-set for that drug line; in this instance the default 'time' will automatically be programmed but can be altered as per 7.5 below.

The pump will then display the following information:

- Medication Name e.g. Aminophylline Load Peripheral
- Total Dose (default start dose) e.g. 5mg/kg
- Time e.g. 30 minutes
- VTBI e.g. 30mL
- Dose (hourly) e.g. 10mg/kg/hr
- Concentration e.g. 50mg/50mL
- Weight e.g. 6kg
- Rate e.g. 60mL/hr

7.4. If the prescribed medication dose is different to the default dose, access dose by pressing the '◄' arrow, adjust the dose as per prescription and confirm by pressing the 'OK' button.

7.5. If the prescribed or clinically appropriate time to infuse the dose over is different to the default time, scroll to time and press 'OK', adjust as required and confirm by pressing the 'OK' button.

7.6. Review all pump settings.

7.7. Attach the giving set to appropriate IV access device.

NB: Where there is a delay in attaching the infusion to the patient, consider re-priming the line directly before connecting to the patient (see note on Line Priming).

7.8. Commence infusion by pressing 'START' key.

7.9. Record dose/volume administered as per policy.

Prescribing of Loading Doses:

A loading dose must be prescribed as a 'once-only' medication order. It is essential that loading doses are administered over a safe and appropriate length of time; the time to infuse over must be stated on the prescription. When the loading dose has been completed, the maintenance infusion can then be programmed if required.

Post Dose Flush:

Due to the priming of the giving set with the prepared infusion, the pump will alarm to alert the user that the syringe/bag is empty prior to completion of the infusion. To ensure the entire dose (VTBI), including that contained in the giving set, is administered, the nurse should deliver a flush through the giving set. This is done by attaching a flush to the same giving set and continuing the infusion within the same programme until VTBI reaches 0mL. In addition to this, a drug line called 'Flush Post Dose' (located in 'All Drugs' therapeutic category) can be used to administer a flush – it should be programmed at the same rate as the medication infusion just completed. Ensure the remaining volume of medication is given at an appropriate rate.

8. Programming a Bolus Medication Dose

This section describes how to administer a bolus dose of medication where a continuous infusion of the required bolus medication is currently infusing.

Note: Prior to administration of a bolus dose, the bolus dose medication order must be confirmed as being appropriate for the current clinical status of the patient. Where a bolus dose is prescribed in a range, the administered dose should be determined with due consideration of the clinical status of the patient and the current rate of the background infusion for that medication. Always check the infusion label to confirm the drug name on the prepared infusion matches the prescription.

NB: Not all medications are permitted to be delivered as a bolus dose by nurses. Reference should be made to the local Medication Policy.

NB: See 4.10 for note on pre-set hard and soft dosing limits.

Administering a Stat Bolus (by a nurse or a clinician):

The bolus will be delivered at a default rate of 200mL/hr. Time can be amended if required; see from 8.9 below.

8.1. Press the **bolus** key

8.2. Press the '◄' arrow to access and set prescribed bolus dose, ensuring dose is set in the prescribed dose/weight unit e.g. microgram/kg and not in total dose (mg) or total volume (mL)

8.3. A second nurse or a clinician should review and confirm the programmed dose prior to administration. Note: See exception under Independent Administration of a Bolus Medication Dose in Appendix 3: Management of SCIs in PICU.

8.4. Commence bolus administration by pressing **bolus** key; a short alarm will be heard and the pump display will indicate when the bolus dose has been delivered, at which point the continuous infusion will resume

8.5. Document bolus check and administration.

Administering a Slow Bolus:

The bolus time can be changed manually to give a bolus dose slower than the default rate of 200mL/hr as may occasionally be needed e.g. to give a midazolam bolus over 2-5 minutes in an unstable patient

8.6. Press the bolus key

8.7. Press the '◄' arrow to access and set prescribed bolus dose, ensuring dose is set in the prescribed dose/weight unit e.g. microgram/kg and not in total dose (mg) or total volume (mL)

8.8. A second nurse or clinician should review and confirm the programmed dose prior to administration

8.9. Press the 'OK' button to access and amend bolus time

8.10. Set the appropriate time for the bolus to be given over using the arrows

8.11. Commence bolus administration by pressing bolus key; a short alarm will be heard and the pump display will indicate when the bolus dose has been delivered, at which point the continuous infusion will resume

8.12. Document bolus check and administration.

Note: A bolus dose can be stopped at any time by pressing the 'OK' button.

9. Recommended Pump Checks

Users should comply with local 'safety check' requirements. Medication orders should be checked against the SCI tables; the order is then checked against the pump and the syringe. For any patient requiring transfer or admission to a ward or other department where smart-pumps containing the drug library are in use, handover checks (prescription against syringe and pump data) should be performed and signed for where provision is made for same.

On the main infusion screen, to review pump data (which can be performed while infusion is ongoing), scroll up or down using the '▲' or '▼' arrow to view a range of data including rate, infusion time and infused volume (highlighted on example provided). These settings are visible in the bottom left corner of the screen.

Press the **'C'** button to view all current pump settings, including drug name, drug concentration, weight and VTBI.

Continuous Infusion Checks

9.1. Change of shift/prescription checks

- Correct Patient
- Correct Drug
- Correct Dose
- Correct Diluent
- Correct Concentration
- Correct Weight **NB**: programmed weight on the pump must be cross-checked with weight on prescription
- Correct Rate (mL/hr)
- Bolus dose settings (e.g. mcg/kg or N/A)

9.2. Hourly checks

- Delta (Δ) volume of pump (volume infused since intermediate settings last cleared – see below)
- Rate on pump
- Administered volume

9.3. Four-hourly checks

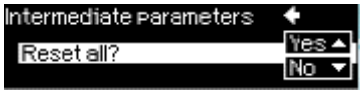
- Syringe level **NB**: Syringe levels must also be checked when the syringe is changed

9.4. 'Zero' Pump Data

The total and intermediate amount of the infused drug can be reviewed and reset from the 'Status' menu. Following safety checks, the delta (Δ) status (volume, time and amount administered) may be cleared as per local ward practice to maintain accurate 24 hour period documentation of total volume(s) infused.

The infusion does not need to be stopped to zero the pump:

- Press 'C' button to access the main menu
- Press '▲' button to 'Status' and press the 'OK' button to select
- Press the left arrow '◄' to 'Δ Volume' (Delta volume). Note: this differs from the ∑ (Sigma) volume.
- Screen will display 'Reset all?': confirm 'Yes' by pressing the '▲' arrow which will reset Delta values to zero.
- Press 'C' button twice to return to the main infusion screen.



10. Syringe/Infusion Bag Changes for Continuous Infusions

NB: this applies to same medication/same concentration infusion changes ONLY

Please follow these instructions where an infusion is ongoing and the syringe/bag and giving set needs to be replaced (same medication/same concentration).

To Change a Non-Critical Infusion with Long Half-Life

e.g. sedatives, opioids, Milrinone (single dedicated line)

a. Disconnect the old infusion from patient
b. Remove syringe/line from pump
c. Load the new syringe/line into the pump
d. Prime the line (if required)
e. Confirm pump settings
f. Connect the new infusion to the patient
g. Start the infusion
h. Dispose of the old infusion syringe/bag and giving set as per hospital guidelines

To Change a Critical Infusion (e.g. Inotropes)

NB: the 'quick change' method should be used - keep the current syringe infusing until the new infusion has been commenced and connected to patient to ensure that there is minimal disruption to medication administration, avoiding adverse cardio-vascular effects:

a. Program a new pump as per Section 5 *and* Section 6 as applicable
b. Start the infusion
c. Perform a quick change at IV device level to remove the old infusion and connect the new infusion to patient
d. Stop the old infusion and dispose of the old infusion syringe/bag and giving set as per hospital guidelines

NB*:* If there has been a delay between programming the pump and attaching to the patient, consideration should be given to re-priming the line immediately prior to connecting to the patient to ensure the medication is at the end of the giving set. This is most important in the critically unwell patient, or where inotropes are running at low infusion rates. See 4.3 for note on Line Priming for further information.

11. Drug Library Additional Features

Blood Products and Maintenance IV Fluids

Blood products and IV fluids (continuous) are available on the Drug Library as 'label only', with the exception of Albumin 20% which is set as a non-continuous infusion with dose/weight limits. A 'label only' drug line has no pre-set dose limits; the medication name (i.e. a label) is displayed on the screen and an upper rate limit is set.

Datalock

Datalock will prevent tampering with the pumps and allow the pump to be stopped but not restarted. Pumps can be locked/unlocked using datalock code **9119**. When the datalock is active, a key symbol is displayed beside the dose on the pump display screen.

Refer to B.Braun manual for full instructions.

Key Lock

The arm of the pump that holds the syringe in place can be locked to prevent the syringe from being removed.

KVO

KVO (Keep vein open) mode is available to be activated if required. This function will deliver a pre-set low flow rate when a manually programmed VTBI expires. The rate will be determined by the rate of the preceding infusion e.g. KVO rate 3mL/hr if infusion rate was >10mL/hr; KVO rate 1mL/hr if infusion rate was <10mL/hr. As this can result in incorrect dosage delivery, KVO should be stopped as soon as possible and the infusion amended to administer the required dose. VTBI can then be reprogrammed as required.

Vasopressin

B.Braun pumps are unable to accommodate 4 decimal places, therefore Vasopressin is administered in units but displayed in mIU (milliunits).

0.001unit = 1milliunit

0.0005units = 0.5 milliunits = 0.5mIU

12. Reporting Incidents/Errors

Medications:

All medication incidents and near-misses identified during the delivery of an IV infusion should be reported by the staff involved as per local policy. To ensure the CHI smart-pump team have full access to, and oversight of, incidents involving the CHI smart-pump drug library, in addition to all the usual details and classifications completed for each incident, **'CHI Smart-Pump'** should also be documented on the incident form. Individual pathways have been established for each site to ensure the relevant incidents marked with the above will be sent to and reviewed by the Smart-pump team. All drug-library issues should be reported to the Smart-pump team

Hardware:

Issues with an infusion pump, giving set or other piece of infusion equipment should be recorded as per local policy. The item(s) of hardware i.e. pump, giving set, should be isolated as soon as appropriate and the relevant personnel notified. All pump/hardware issues (e.g. battery, connectivity, syringe/giving set insertion) should be reported to clinical/biomedical engineering. If appropriate to do so, photographs/video footage of the pump and/or equipment should be taken and forwarded to the smart-pump team and/or clinical/biomedical engineering to allow the most comprehensive troubleshooting review.

Appendix 1: Standard Concentration Infusion Tables

Standard Concentration Infusion tables should be reviewed prior to infusion preparation to ensure the correct concentration is prepared.

There are six separate care units within the CHI (Version 4) Drug Library:

Emergency Departments/Wards/Day Units *[currently named 'Emergency Department' (Crumlin and Temple Street or 'UCC Main Library' (Connolly and Tallaght)]*
PICU/Theatre
Children's Heart Centre (CHC)*
CVVH (Continuous Veno-Venous Hemofiltration)
ECLS (Extracorporeal Life Support)
Metabolic Agents*

Separate Continuous and Non-Continuous Infusions SCI Tables are available for the following care units:

- Emergency Departments/Wards/Day Units
- PICU/Theatre
- Children's Heart Centre (CHC)*

Continuous Infusions

All infusions which, by default, are intended to be run on an ongoing basis over a number of hours/days based on clinical need. This table also has loading doses listed alongside the corresponding continuous infusion. These loading doses and continuous infusions are prepared to the same concentration, allowing both the load and the subsequent continuous infusion to be administered from a single prepared infusion solution. This removes the requirement for separate syringe/bags to be prepared for the load and the continuous infusion.

Non-Continuous Infusions

All infusions which are intended to deliver a specific dose of medication/fluid over a specific time. These infusions should have a volume to be infused (VTBI) programmed to ensure that only the required dose is administered.

Single SCI Tables are available for the following care units:

Note: *On the Crumlin Intranet, these SCI tables are located under the PICU/Theatre tab.*

- CVVH (Continuous Veno-Venous Hemofiltration)
- ECLS (Extracorporeal Life Support)
- Metabolic Agents*

** Care unit likely to be removed on the CHI (Version 5) Drug Library due to be implemented Q1 2021.*

Each table contains the following information:

1. **Drug** – the name of the drug; any additional information (e.g., central/peripheral route, Weight-based/Non weight-based, Weight inclusions/restrictions, comments)
2. **Therapeutic Category** (see 4.6)
3. **Weight Band** (see 4.5)
4. **Standard Concentration Infusion (SCI)** – this is the default concentration to be used for each listed weight band. In PICU, a high strength SCI is also available for most continuous infusions to enable smaller volumes to be infused where fluid-restriction is required. Outside of PICU, a higher SCI is only available for a small number of medications; this will always be offered as a separate drug line e.g. Vancomycin and clearly named as 'Vancomycin HIGHER CONCENTRATION'
5. **Diluent** – based on medication compatibility e.g. Esomeprazole (NaCl 0.9% only), metabolic agents (Glucose 10% only)
6. **Usual Dose Range** – dose/weight/time (e.g. Aminophylline Maintenance Peripheral: 0-1mg/kg/hr). For *Non-continuous infusions only*, in addition to the usual dose, the usual time to infuse over and the dosing interval may also be included (e.g. Benzylpenicillin: 25-50mg/kg over 30 minutes 8-12 hourly).
7. *Continuous/Metabolic Tables*: **Default Start Dose** – the dose at which the medication is most commonly commenced; in most instances this can be amended.

   or

   Non-Continuous Table: **Default Dose** – the most commonly used dose; in most instances this can be amended.

   Note: Where large dose ranges are commonly used, no default start dose/default dose is stated (these fields may be blank) to allow the prescriber to select the most appropriate dose.

8. *Continuous/Metabolic Tables*: **Default Rate (mL/hr)** – calculation formula to confirm the rate of infusion when the pump is administering the default dose. See Appendix 2: Manual Rate Calculations for further information on rate calculations for doses other than the default

   or

   Non-Continuous Table: **VTBI (mL)** – calculation formula to confirm the final volume to be administered to the patient. Where there is a large dose range, this may be blank due to omission of a default dose.

Appendix 2: Manual Rate Calculations for Continuous Infusions

*The pump will calculate the rate of infusion according to the programmed patient and medication data. The examples below indicate how to **manually** check a continuous infusion rate where required.*

Rate Calculation for Default Start Dose

In the standard concentration infusion table, go to the column labelled '**Default Dose and Rate Calculator**' for Default Start Dose and Default Rate (mL/hr) and calculate as per given formula.

Example 1:

Milrinone Infusion for Patient Weight 4.2kg

Standard Concentration for all ≤5kg =
Milrinone 5mg/50mL =
5000microgram/50mL =
100microgram/mL

Default Start Dose =
0.5microgram/kg/**min** → (0.5 x 60) microgram/kg/**hour** = **30 microgram/kg/hour**

Calculation of hourly rate (volume) equivalent to 30 microgram/kg/hour:
100 microgram = 1mL →
30 microgram = 30 ÷ 100 = **0.3mL**/kg/hour

Default Rate (mL/hour) for Default Start Dose **= 0.3 x wt (kg) mL/hour**
Default Rate = (0.3 x 4.2kg) = 1.26mL/hour

For high-strength infusions (PICU/Theatre care unit ONLY): use the High Strength Default Rate (mL/hour) value from the 'High Strength (Fluid restricted patients)' column on the right hand side of the table

Rate Calculation for Dose other than Default Start Dose

Example 2

Milrinone Infusion for Patient Weight 4.2kg
Prescribed start dose: 0.75 microgram/kg/min

Actual Dose Required = 0.75microgram/kg/min

Calculate the default values (as in Example 1 above):

Default Start Dose = 0.5microgram/kg/min (as per SCI table)
Default Rate = 1.26mL/hour (see Example 1 above)

Use the formula (as printed on Continuous SCI tables):

$$\text{Actual Rate (mL/hour)} = \frac{\text{Required Dose} \times \text{Default Rate (mL/hr)}}{\text{Default Start Dose}}$$

$$= \frac{0.75 \times 1.26}{0.5}$$

$$= 1.89\text{mL/hour}$$

NB: If the calculated rate does not match the pump rate for the actual dose, recheck calculations and all settings on the pump

Appendix 3: Management of SCIs in PICU

Where ICCA® is not used, the following should be replaced with locally approved procedures.

Prescription

All medications should be first prescribed on PICU Clinical Information Management System (ICCA®), or on an approved CHI paper prescription if ICCA® prescribing is not available (including when an infusion is being prepared for a patient not yet admitted to PICU). If for any reason ICCA® prescribing is not available for a patient admitted to PICU, all medications should be charted retrospectively on ICCA® as soon as possible.

High Strength Concentrations

A number of medications are offered **two concentrations** within each weight band (see samples below). If the high strength concentration is required, the prescriber has the option to indicate this on the ICCA® order. It is essential to be vigilant when selecting the drug concentration to ensure correct volumes will be delivered to patient and patient safety is maintained. **Exceptions**: Some medications have a range of standard concentrations that do not fall into the 5 weight bands e.g. ECLS Heparin (found in ECLS Care Unit) has three weight bands: 0-10kg, >10-30kg, >30kg; Epoprostenol (Flolan®) has up to four offered concentrations.

Weight

When entering patient weight into the pump, ensure the current working weight (up to 2 decimal places) is entered as displayed on the ICCA® flowsheet (under 'Vital Signs'). No other weight e.g. Admit weight should be used.

Documentation

ICCA® provides space for two nurses to sign for both preparation and pump programming. Dose changes should be also signed for by both nurses on ICCA® following pump amendment.

Exception: A senior nurse who has completed their IV policy can change a dose independently where a second nurse is not available at the bedside *and* the clinical status of the patient indicates that immediate dose change is required. The dose change should subsequently be checked and signed for by a second nurse as soon as is possible.

Pump Assignment

All continuous infusion orders should be assigned to the corresponding pump on ICCA® to allow accurate recording of administered doses and volume of medication delivered to patient. If an infusion is ordered on a paper prescription, the pump can be retrospectively assigned to the actual infusion start time following ICCA® prescription. A pump cannot be assigned to ICCA® for non-continuous infusions, therefore the volumes delivered by the pump will not auto-fill. The volume infused must be manually added in to ICCA®.

Independent Administration of a Bolus Medication Dose *NB CHI at Crumlin ONLY*

A senior nurse can administer a bolus dose independently where a second nurse is not available at the bedside *and* the clinical status of the patient indicates that a bolus dose is required *immediately*. He/she should document on ICCA® that no second check was available.

Receiving a Patient into PICU from another Hospital/Transport Team

Where a patient is being admitted to PICU, to allow for PICU to have infusions ready to administer to the incoming patient in a timely manner, infusions can be ordered by the receiving medical team on a prescription sheet based on the working weight communicated by the previous hospital or transport team. All prescriptions must be subsequently ordered in ICCA® as soon as the patient has been electronically admitted and has a CHI MRN, at which point pump assignment can be allocated to the time the infusion actually commenced.

Where there is a discrepancy in handover weight and PICU weight, the medical team may choose to amend working weight, in which case the prescription must be modified to reflect the new working weight. If the child's weight has moved to a new weight band with a different concentration, a new infusion will need to be prepared in the correct concentration. The pump must be re-programmed to reflect all changes made.

Handover of Infusions for Administration outside PICU *NB CHI at Crumlin ONLY*

Occasionally, PICU nurses are required to prepare infusions for a patient in another clinical area. A paper prescription will be required for infusions that are being prepared for administration in any other area outside of PICU and for a non-PICU patient.

NB: high concentration SCIs should only be used outside of PICU when prescribed in exceptional circumstances

Preparation

The two nurses who prepare the infusion(s) and programme the pump(s) sign the prescription for both the preparation and programming.

Handover

All infusions and prescriptions must be handed over to, and checked by, the consultant/registrar caring for the patient. One of the nursing staff who prepared the infusions should aim to bring the infusions to the requesting area (theatre department, ED, etc.). However, where this is not possible, the infusions will be collected by the requesting Consultant/Registrar. The PICU CNM 3 or shift leader on duty will make this decision and notify the relevant staff.

1. Cross-check the infusion and pump against the prescription and SCI table, ensuring correct patient name, MRN, drug concentration and weight.
2. Both nurse and consultant/registrar sign the prescription sheet to confirm handover. At this point the infusions become the responsibility of the consultant/registrar.

FOR NON-ICU CLINICAL AREAS:

In exceptional circumstances and with a valid prescription, the PICU/Theatre SCI Drug Library can be accessed in other clinical areas in which SCIs are used to administer a medication and/or concentration which is not available in that area's SCI drug library.

Appendix 4: Intra-Hospital Transfer of Patient on an Ongoing Infusion within CHI

Where a patient is being admitted to a new clinical area receiving an ongoing IV infusion(s), all infusions must be ordered on a prescription sheet which must accompany the patient on transfer. The nurse handing over care of the patient and the nurse receiving care of the patient should check the following for each infusion:

- Correct patient identifiers on all documentation and medication
- Medication order on prescription sheet
- Pump settings: medication, concentration, weight, rate, dose, bolus dose – ensure that all settings match the medication order and that the working weight is used
- Total volume infused recorded on intake/output sheet
- Syringe label
- Syringe level
- IV access device through which the medication is currently infusing

Once checks have been performed, the handover nurse and the receiving nurse should both sign the prescription sheet to confirm handover of infusion(s).

Transfer of Patient from PICU to Theatre/Cath. Lab./Radiology Dept.with Ongoing Infusions

All ongoing infusions are handed over to receiving staff as part of the patient handover.

Note: a handwritten prescription is not usually required as patients leaving PICU for procedures with infusions running will have an ICCA® Patient Summary printed *NB CHI at Crumlin ONLY*.

Transfer of Patient to a Different 'Care Unit'

Where a patient is moving to another 'Care Unit' clinical area, the infusion does not need to be reprogrammed to the new Care Unit immediately. For a continuous infusion, this can be done when it is safe to stop the infusion or when a new pump is being programmed for the infusion. For non-continuous infusion, allow the current programme to complete and change the care unit in advance of the next Drug Library programming.

Appendix 5: Maximum Flow Rates on B.Braun Perfusor® Pumps

B.Braun Perfusor® pumps have maximum rates at which they can deliver infusions. These are determined by the size of the syringe being used. This applies to the use of the pump irrespective of the drug library. Delivery of a small number of infusions on the drug library may be restricted by these limits. Where maximum rates are exceeded, the pump will display one of the warnings as seen in Figure 4 below:

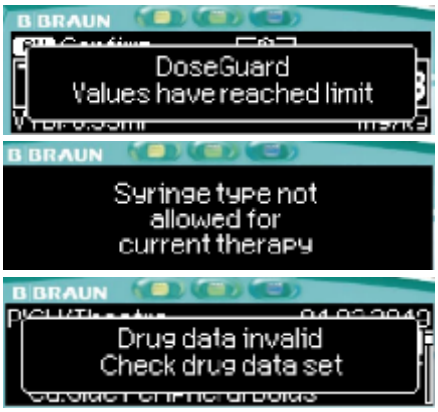


Figure 4: Syringe incompatibility notifications on B.Braun Perfusor® pump

Some SCIs are configured in the drug library with variable times to infuse over (e.g. 5-60 minutes; 10-30 minutes). The maximum pump rate, as defined by local pump modification settings, may restrict the pump from running the infusion at the lower (faster) time. Maximum pump rates for different syringe sized are displayed in Table 2. Where this occurs, the pump will automatically increase the programmed infusion time, while remaining within the pre-set time limits. These limits apply in all circumstances of Perfusor® pump use, regardless of use of drug library.

Solutions:

- Increase syringe size
- Increase time to infuse over (where possible)

Table 2: Minimum/Maximum Rate Range per Syringe Size on B.Braun Perfusor® Pumps as per CHI Modification Files

Syringe Size (mL)	Flow Rate Range (mL/hour)
50/60	0.01-200
30/35	0.01-100
20	0.01-100
10/12	0.01-50
5/6	0.01-50
2/3	0.01-25

Appendix 6: Preparation of SCI Infusions using Empty Sterile Bags

PAEDIATRIC STANDARD CONCENTRATION INFUSION DRUG LIBRARY

Preparation of Standard Concentration Infusion via Empty Sterile 250mL Bag

To be used in conjunction with the 'Standard Operating Procedure for Use of the Children's Health Ireland Paediatric Smart-Pump Drug Library'.

Preparation of large volume infusions (>50mL, ≤250mL) where syringe/buretrol not suitable:

1. Equipment

1 x sterile 50mL syringe
1 x sterile 250mL infusion bag*
1 x IV infusion set
1 x blunt needle with filter
1 x needle-free device
1 x small bore filter extension set
1 x sterile tray
1 x Medication label
2% Chlorhexidine in 70% Alcohol wipes

2. Preparation and Administration

Using Aseptic Non-Touch Technique (ANTT) Level 3 (or level 1/2 as appropriate):

a) Prepare solution for infusion in 50mL syringe using the blunt needle with filter
b) Detach the white cap from the access port of the bag (centre access point below clamp)
c) Attach the needle-free device to the access port. Clean with alcohol wipe and allow to dry for 30 seconds.
d) Connect 50mL syringe to the needle-free device and insert fluid into bag. Repeat as necessary to fill the bag to the desired volume no greater than 250mL (bag capacity) and close the clamp NB once the clamp is closed it cannot be reopened
e) Affix a completed medication label to the bag
f) Detach the blue cap and pierce the access port with the IV infusion set
g) Check bag for particles as the entry port may core when pierced. If visible particles are present, dispose of the bag and begin preparation from step (a) above. To allow for invisible particles, see following step.
h) Attach small bore filter extension set to the infusion set; prime the set
i) Load IV infusion set into infusion pump and programme pump as per prescription and SCI SOP where applicable
j) Attach to patient and commence infusion.

*Baxter Eva Empty Bag product reference code: E3MC3801A

STANDARD CONCENTRATION INFUSION DRUG LIBRARY
Informatics/Smart Pumps
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Appendix 7: Preparation of Standard Concentration Infusions using IV Fluid Bags

Children's Health Ireland

PAEDIATRIC STANDARD CONCENTRATION INFUSION SMART-PUMP DRUG LIBRARY

Instructions for the Preparation of Standard Concentration Infusions (SCIs) using IV Fluid Bags

Note: Information in this document is to be used in conjunction with the 'Standard Operating Procedure for Use of the Children's Health Ireland Paediatric Smart-Pump Drug Library'.

Preparation of standard concentration infusions and compliance with the CHI smart-pump library for certain medications can require reconstitution and dilution directly into IV fluid bag of diluents e.g. 100mL, 250mL, 500mL Sodium Chloride 0.9%. Example scenarios include: lack of access to a buretrol set or sterile empty 250mL bag; where an infusion exceeds 250mL.

As IV diluent fluid bags contain an overage of volume (see Table 1 below), this must be accounted for to ensure an accurate final concentration when preparing SCI medications. Failure to do so may result in incomplete delivery of prepared doses.

Table 1: Overage Volumes in Baxter 100mL, 250mL, 500mL Viaflo Bags[1]

Nominal Volume In Bag	Average Actual Volume in Bag	Maximum Volume for Addition to Bag	Maximum Volume capacity of Bag
100mL	111mL	77mL	111mL + 77mL = 188mL
250mL	271mL	167mL	271mL + 167mL = 438mL
500mL	530mL	295mL	530mL + 295mL = 825mL

Reference: Baxter Healthcare

Sample prescription and calculations for preparation:

Patient: Peg O'Toole	DOB: 05/03/20XX	MRN: 111111	Weight: 55kg
Drug: **Vancomycin**	Route: IV	Dose: 825mg (15mg/kg)	Frequency: QDS

- Reconstitute Vancomycin 500mg vial as per CHI formulary to give a 50mg/mL solution
- Dose prescribed as above: 825mg
- Volume Vancomycin (50mg/mL) to be withdrawn from vial: 16.5mL (825mg)
- SCI for Vancomycin: 5mg/mL (*see SCI Table*)
- Volume to be Infused (VTBI): Total dose ÷ SCI = 825mg ÷ 5mg/mL = 165mL **final infusion volume**
- Volume of diluent required = Final infusion volume – Dose volume = 165mL - 16.5mL = 148.5mL
- 271mL already in IV fluid bag (as per table 1 above: 250mL bag + 21mL overage)
- Volume to be withdrawn from IV fluid bag: 271mL (volume in bag) – 148.5mL (volume of diluent required) = 122.5mL (discarded)
- Add 16.5mL Vancomycin to the 148.5mL remaining in the IV fluid bag
- Final VTBI and IV fluid bag volume content: 165mL

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Appendix 8: Preparation of Small Volume Infusions requiring 0.3mL Giving Sets

PAEDIATRIC STANDARD CONCENTRATION INFUSION DRUG LIBRARY

Preparation of Standard Concentration Infusions that require 0.3mL giving sets

To be used in conjunction with the 'Standard Operating Procedure for Use of the Children's Health Ireland Paediatric Smart-Pump Drug Library'.

In the event of running an infusion that is a lower volume than usual giving sets (e.g. CHI @ Crumlin = 1.4mL, CHI @ Temple Street = 1.6mL or 2mL), please use 0.3mL giving set [B.Braun Combidyn-Press. Tube PE 30 cm, Transp. (reference no. 5214993)].

Sample calculation:

Patient: Peg O'Toole	DOB: 05/06/2020	MRN: 111111	Weight: 2kg
Drug: **Paracetamol**	Route: IV	Dose: 15mg (7.5mg/kg)	Frequency: QDS

- Volume of Paracetamol (10mg/mL) to be withdrawn: 1.5mL
- SCI for Paracetamol: 10mg/mL (*see SCI Table*)
- VTBI: 15mg ÷ 10mg/mL = 1.5mL **final infusion volume** (Neat solution-no further dilution required)
- B.Braun Combidyn-Press 0.3mL giving set, programme and deliver the dose
- N.B. Flush through giving set to ensure patient receives full prescribed dose

STANDARD CONCENTRATION INFUSION DRUG LIBRARY
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Appendix 9: CHI Smart-Pump Training Exercises and Assessment

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PAEDIATRIC STANDARD CONCENTRATION INFUSION DRUG LIBRARY

Non-Continuous Infusion Example: Aciclovir

Patient: Peg O'Toole	DOB: 05/03/2015	MRN: 111111	Weight: 22kg
Drug: **Aciclovir**	Route: IV	Dose: 220mg (10mg/kg)	Frequency: TDS

1. Volume of Aciclovir (250mg/10mL) to be withdrawn from vial:

   [(220mg ÷ 250mg) x 10mL] = **8.8mL**

2. Final VTBI:

   Total dose ÷ final infusion concentration *(see SCI table)*

   220mg ÷ 5mg/mL= **44mL**

3. Volume of diluent:
   44mL-8.8mL = **35.2mL**

Programme the infusion on the smart pump:

1. Insert Syringe/Giving set
2. Prime line?: Select 'No' (specific volume – to avoid losing some volume to be infused)
3. Drug Library → Care Unit → Weight Band → Therapeutic Category → Select Drug → +/- Pop up → Confirm Weight +/- Dose +/- Time → Review/Amend Programme → Start

Care Units
Paed ED/Ward
CVVH
ECLS
Metabolic
PICU/Theatre

Weight Bands
0-2.5kg
>2.5-5kg
>5-10kg
>10-20kg
>20kg

Therapeutic Categories
Antimicrobials
Cardiovascular
Central Nervous System
Endocrine/GI
Fluids, Electrolytes, Nutrition
Haematology
Respiratory
Other

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PAEDIATRIC STANDARD CONCENTRATION INFUSION DRUG LIBRARY

Continuous Infusion Example: Insulin

Note: Insulin dosing varies depending on requirement (Neonatal Hyperglycaemia or DKA). Always amend your start dose as per prescription.

Patient: Jack Jones	DOB: 05/05/2010	MRN: 888888	Weight: 30kg
Drug: **Insulin**	Concentration: 50units in 50mL 0.9% Sodium Chloride	Route: IV	Dose: 0.1 unit/kg/hr (continuous)

1. Volume of Insulin (100 international units/mL) to be withdrawn:

   [(50iU ÷ 100iU) x 1mL] = **0.5mL**

2. Final infusion volume:

   50mL

3. Volume of diluent:

   50mL – 0.5mL = **49.5mL**

Programme the infusion on the pump:

1. Insert Syringe/Giving set
2. Prime line?: Select 'No'
3. Drug Library → Care Unit → Weight Band → Therapeutic Category → Select Drug → +/- Pop up → Confirm Weight +/- Dose +/- Time → Review/Amend Programme → Start

Rate check calculations (see table for formula and default values):

0.02 x Wt = 0.02 x 30kg = **0.6mL** *at default start dose of 0.02unit/kg/hr*
Increase dose to 0.1 unit/kg/hr as per prescription

Recalculate rate at amended dose:

$$\frac{\text{Required Dose} \times \text{Default Rate (ml/hour)}}{\text{Default Start Dose}} = \frac{0.1 \times 0.6}{0.02} = \textbf{3mL/hour}$$

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PAEDIATRIC STANDARD CONCENTRATION INFUSION DRUG LIBRARY

Non-Continuous Infusions

Review Non-Continuous SCI Table before preparing the infusion

Perfusor® pump (≤50/60mL) or Infusomat® pump (>50/60mL)

Non-Continuous Infusion: Paracetamol

Patient: Mary Murphy	DOB: 01/04/2019	MRN: 222222	Weight: 7.5kg
Drug: **Paracetamol**	Route: IV	Dose: 56mg (7.46mg/kg)	Frequency: QDS

Volume of Paracetamol (500mg/50mL) to be withdrawn: ____mL

Final VTBI: ____mL (Total dose ÷ final infusion concentration) *see SCI table*

Volume of diluent: ____mL

Programme the infusion on the pump

Flush

Non-Continuous Infusion: Phenytoin

Note: Phenytoin Load is currently available on the drug library; for maintenance dose administer off library

Patient: Ella Ellis	DOB: 05/03/2019	MRN: 333333	Weight: 25kg
Drug: **Phenytoin (Load)**	Route: IV	Dose: 500mg (20mg/kg)	Frequency: Stat

Volume of Phenytoin (250mg/5mL) to be withdrawn: ____mL

Final VTBI: ____mL (Total dose ÷ final infusion concentration) *see SCI table*

Volume of diluent: ____mL

Programme the infusion on the pump

Flush

Non-Continuous Infusion: Gentamicin

Patient: John Johnson	DOB: 08/01/2020	MRN: 444444	Weight: 7kg
Drug: **Gentamicin**	Route: IV	Dose: 49mg (7mg/kg)	Frequency: OD

Volume of Gentamicin (20mg/2mL OR 80mg/2mL) to be withdrawn: ____mL

Final VTBI: ____mL (Total dose ÷ final infusion concentration) *see SCI table*

Volume of diluent: ____mL

Programme the infusion on the pump

Flush

Non-Continuous Infusion: Magnesium Sulphate

Patient: Molly Malone	DOB: 17/04/2019	MRN: 555555	Weight: 15kg
Drug: **Magnesium Sulphate**	Route: IV	Dose: 3mmol (0.2mmol/kg)	Frequency: BD

Volume of Magnesium Sulphate (2mmol/mL) to be withdrawn: ____mL

Final VTBI: ____mL (Total dose ÷ final infusion concentration) *see SCI table*

Volume of diluent: ____mL

Programme the infusion on the pump

Flush

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PAEDIATRIC STANDARD CONCENTRATION INFUSION DRUG LIBRARY

Continuous Infusions and Loading Doses

Review Continuous SCI Table before preparing the infusion

Perfusor® pump (≤50/60mL) or Infusomat® pump (>50/60mL)

Continuous Infusion and Loading Dose: Aminophylline

Patient: Polly Pocket	DOB: 21/12/2014	MRN: 666666	Weight: 25kg
Drug: **Aminophylline Load**	Route: IV	Dose: 125mg (5mg/kg)	Frequency: STAT

Volume of Aminophylline (25mg/mL) to be withdrawn: ____mL
Volume of diluent: ____mL
Load VTBI: ____mL (5 x Wt) *see SCI table*
Programme and deliver the loading dose
Do not flush post dose is maintenance is prescribed

Patient: Polly Pocket	DOB: 21/12/2014	MRN: 666666	Weight: 25kg
Drug: **Aminophylline Maintenance**	Concentration: 500mg in 500mL 5% Glucose	Route: IV	Dose: 0.5mg/kg/hour (continuous)

Default start rate of maintenance infusion: ____mL/hour (0.5 x Wt) *see SCI table*
Programme and start the maintenance infusion at the default dose

Continuous Infusion and Bolus Dose: Midazolam

Patient: Polly Pocket	DOB: 21/12/2014	MRN: 666666	Weight: 25kg
Drug: **Midazolam**	Concentration: 100mg in 50mL 5% Glucose	Route: IV	Dose: 1 microgram/ kg/min (continuous)

Volume of Midazolam (10mg/2mL) to be withdrawn: ____mL
Volume of diluent: ____mL
Final infusion volume: ____mL
Default start rate: ____mL/hour (0.03 x Wt) *see SCI table*
Programme and start the infusion
Reduce dose to 0.5microgram/kg/min
Calculate amended rate *see formula on SCI Table*
Give a bolus dose of Midazolam: 50micrograms/kg BOL → change dose from 0 → BOL
Zero the pump to clear/restart 24 hour fluid balance count
Stop and clear the programme

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PAEDIATRIC STANDARD CONCENTRATION INFUSION DRUG LIBRARY

Assessment

Following my Drug Library training, I can do the following:	YES	FT*
Access SCI Tables		
Calculate final infusion volume		
Identify relevant pump to be used		
Load a syringe/giving set		
Prime line		
Change care unit		
Select correct weight band		
Use alphabetical quick reference to access required drug		
Set drug order parameters e.g. weight, dose		
Calculate rate at default dose		
Access all parameters from home screen		
Change rate/dose		
Calculate rate at amended dose		
Give a bolus medication dose		
Zero pump data without clearing the pump programme		
Identify a soft/hard limit warning		
Clear all information and reset pump		

*FT: Further training requested

Name: _____

Grade: _____

Department: _____

Hospital: _____

Date of Training: _____

Session facilitated by:

Name/Grade: _____ Signature: _____

Please give completed assessment to your CNEF.

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Differences in available drug preparations, and the manner in which concentrations are expressed, can produce minor discrepancies in final concentrations and calculated flow rates. In recognition of the need to stabilise children, other settings/hospitals may refer to this SOP but are solely responsible for all acts or omissions carried out in connection with, or in reliance on the material provided.