Children's Health Ireland

Crumlin & Temple Street

ADMINISTRATION OF KETAMINE INFUSIONS VIA ARCOMED® PUMP ON THE WARD FOR ACUTE PAIN MANAGEMENT SOP

Area of use:	All of organisation ☐	CHI at Connolly ☐	CHI at Crumlin ☒
	CHI at Herberton ☐	CHI at Tallaght ☐	CHI at Temple Street ☒
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Approved by & title:	Drugs and Therapeutics Committee		
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Version History

Version:	Date approved:	Summary of changes:	Author:

Contents

1.0 SOP Statement

Ketamine is an anaesthetic with significant analgesic properties. The primary mechanism of action of ketamine is via blockade of N-Methyl-D-aspartic acid (NMDA) receptors in the peripheral and central nervous system. NMDA receptors play a key role in central sensitisation and modulation of pain signals. Blockade of these receptors by ketamine accounts in part for its anti-hyperalgesic and analgesic properties (ANZCA, 2020).

A low dose ketamine infusion can be useful in treating acute pain states, usually in conjunction with opioids to either reduce the total opioid dose or to supplement analgesia where increasing doses of opioids have failed to help the pain. In some circumstances a ketamine infusion may be used alone (Schwenk *et al*.,2018).

2.0 Scope

This guideline involves all medical and nursing staff involved in the prescribing, preparation, administration and monitoring of patients receiving intravenous (IV) ketamine infusions for acute pain outside of the PICU & Theatre setting. The areas authorised are:

- Our Lady's Ward CHI at Crumlin
- St. Joseph's Ward CHI at Crumlin
- Surgical Flat CHI at Temple Street

IV Ketamine must only be administered via the drug library of the Syramed® SP6000 syringe driver from Arcomed AG (referred to in CHI as the 'Arcomed' pump). The prescription and management of ketamine infusions is the responsibility of members of the Department of Anaesthesiology and the Pain Service.

2.1 Proposed prescribers

1. Consultant Anaesthesiologist.
2. Consultant Pain Physician.
3. Consultant Intensivist.
4. NCHDs in Anaesthesiology or nurse prescribers in the pain service in consultation with 1-3.

2.2 Authorised Personnel – Training Required

a) It is the responsibility of relevant medical and nursing staff to familiarise themselves and adhere to the contents of this guideline.

b) Members of nursing staff authorised to manage intravenous ketamine infusions must:
- Be a registered nurse
- Have completed IV Study Day (including Arcomed smart-pump training and competency as per Appendix 3).
- Attend additional training (Pain study day, dedicated education sessions re: ketamine infusions) provided by the Department of Anaesthesiology /Pain Service/Smart-pump Team/Clinical Nurse Education Facilitator/ Clinical Nurse Manager 2 / Centre for Children's Nurse Education.
- Have the necessary skills & competencies to monitor children and notify medical staff of effectiveness and/or of complications of this treatment.

3.0 Indications for use

a. Patients with acute pain, in whom multimodal therapy with local/regional anaesthesia, opioid, paracetamol and NSAIDs as appropriate, are not providing adequate pain relief.
b. Where opioid tolerance has developed and a patient is requiring increasing doses of opioids with poor effect.
c. Patients with acute pain who are developing neuropathic pain.
d. Specific acute pain conditions e.g. mucositis, typhlitis, burns, sickle cell crisis, management of post-operative pain e.g. spinal fusion for scoliosis repair

4.0 Contraindications

Absolute: Known or strongly suspected allergy to ketamine and patient refusal.

Relative: At the doses recommended in this protocol, most contraindications are relative. **Caution** should be used in prescribing a ketamine infusion for patients who suffer from the following:

- Uncontrolled hypertension
- Cardiac failure
- Cerebrovascular disease
- Raised intracranial pressure
- Raised intraocular pressure
- Acute intermittent porphyria
- Hyperthyroidism or patients receiving thyroid replacement (increased risk of hypertension and tachycardia)
- Seizures/Epilepsy
- Hallucinations/delirium
- History of psychosis
- Patients receiving sedative medications (the effect will be cumulative).

5.0 Side Effects

As ketamine is started at the lowest dose the following side effects should be minimal. Side effects below may limit a patient's ability to tolerate higher infusion rates. A small reduction of the dose will often resolve the side-effect but retain analgesic benefit in the majority of cases. Serious side effects warrant stopping the infusion. Contact the pain service/anaesthesiology in all instances for advice:

- Sedation
- Cardiovascular stimulation resulting in hypertension and tachycardia (bradycardia and hypotension have also been reported)
- Increased intracranial pressure
- Hallucinations, dysphoria, and vivid dreams (patients, parents and staff should be made aware of this side effect). Minimise by starting at low doses.
- Respiratory depression/apnoea
- Hypersalivation
- Laryngospasm (rare - due to an increase in secretions and maintenance of airway reflexes)
- Diplopia and nystagmus
- Purposeless movements or tonic-clonic movements

6.0 Drug Interactions

The following is not an exhaustive list – full details can be found in ketamine summary of product characteristics (SPC) on www.hpra.ie. These combinations are not absolutely contraindicated but caution is needed in all instances and monitoring of effects and dose adjustment may be required.

- Aminophylline & Theophylline – increased risk of convulsions with ketamine
- Thyroxine – ketamine may exacerbate hypertension and tachycardia
- Opioids – ketamine may sensitise patients to opioids, reduce current opioid doses in patients who are opioid toxic before commencing ketamine infusion
- Diazepam & other sedatives/hypnotics – concurrent use will increase plasma levels and reduce clearance rate of ketamine
- Atracurium – ketamine enhances the effects of atracurium
- Patients receiving sedative medications (e.g. antihistamines, benzodiazepines, opioids or anticonvulsants) may be at increased risk of sedation and respiratory depression (the effect will be cumulative).

7.0 Procedure

7.1 Set up and management

Ketamine continuous infusion for analgesic purpose must only be administered via Arcomed smart pump using the CHI drug library. Prepare Ketamine infusion as per the Standard Concentration Infusion table in the CHI Paediatric Formulary **Ketamine (Via Arcomed)** monograph.

7.2 Preparation & Dose

Prepare ketamine infusion in accordance with CHI local medication policy.

- Dilute required amount of medication with Sodium Chloride 0.9% w/v or Glucose 5% w/v - use standard concentrations as per SCI tables.
- Label syringe as per CHI policy. Label the infusion line clearly with a ketamine yellow sticker as an additional safety feature.
- If possible, preferably administer via central venous access device to avoid potential venous irritation as the preparation has a low pH. It is possible to co-administer via a peripheral cannula with I.V fluids using an octopus connector.

7.3 Recommended Paediatric-Dosing

7.3.1 Intravenous: Continuous Infusion

a. The usual starting dose is 1-2 micrograms/kg/minute but also see below under 8.3.2 for advice about starting doses according to patient's pain scores. Default starting dose on smart pump - 2 micrograms/kg/minute. Range 1-4 micrograms/kg/minute. (See model prescription Appendix 1)

b. Maximum dose of 250micrograms/minute.

c. Titrate up if needed according to patient analgesia versus side effects. Titrations should be made in increments of a maximum of 1 micrograms/kg/minute.

7.3.2 Starting doses based on pain scores

a. Assess patient's pain using age and developmentally appropriate pain scale. If pain score is 4 - 7, commence infusion at 2 micrograms/kg/minute. Reassess pain after 1 hour. If pain not controlled (pain score >7), increase to 4 micrograms/kg/minute (maximum dose). Inform pain team/ anesthesiology that infusion needed to be increased. Be cognizant of side effects noted in section 6.0 following increases to the infusion rate. If pain still not controlled, consider other alternatives to ketamine for pain relief.

b. If pain score is >7, commence infusion at 4 micrograms/kg/minute (maximum dose).

c. Doses can be reduced very gradually once clinically appropriate. This will be assessed every 24 hours by senior members of the anesthesiology/pain service team.

7.4 Monitoring

Pain assessment is performed using age and developmentally appropriate pain scales and documented at rest and on movement. This is to be documented in PEWS and indicate which method of assessment is being utilised.
The following should be monitored just prior to administering the infusion and continued as indicated below while the infusion is running. Monitor more frequently if the patient's condition requires it or after dose titrations. All documentation should be recorded in CHI Ketamine Infusion Monitoring Sheet, in addition to PEWS chart. Please see Appendix 2.

Monitor and document the following:

Continuous:

- **All children must have continuous pulse oximetry** (SpO_2) **monitoring the duration of Ketamine infusion**
- Under 12 months' apnoea/ respiratory monitoring to be used

5 minutes:

- Respiratory rate and AVPU every 5 minutes for 15 minutes post dose titration

15-30 minutes:

- Pain score after an increasing background infusion or administration of supplemental analgesia

Hourly:

- Heart Rate, Respiratory Rate, Pain Score, AVPU, nausea
- Pump including background dose, drug administered, syringe volume
- IV access site

4 hourly:

- blood pressure and temperature (more often if clinical condition dictates)
- If pain is controlled, pain assessment can be decreased to 2-4 hourly thereafter.

Prior to ambulation:

Patients may be at increased risk of falling when Ketamine is first initiated. Check orthostatic vital signs prior to ambulation for the first time after beginning the infusion. Do not ambulate the patient if there are any sign/symptom of hypotension.

Any observations outside reportable limits (as identified on the clinical observations) or outside normal values for age should be reported to the Acute Pain team or Anaesthesiology Registrar on call (out of hours).

7.5 Troubleshooting

Please note that if the following scores/observations occur the following action should be taken:	
Patient unrousable / Respiratory depression	• If respiratory depression or over sedation is suspected: • Stop ketamine infusion and all other infusions that could be contributing to sedation e.g. opioid infusion. • Attempt to rouse patient. • Call 2222 and follow local resuscitation guidelines. • Administer Naloxone (dosing and guidance in CHI Paediatric Formulary) if opioid toxicity is suspected and the patient is receiving a concurrent opioid infusion or P/NCA.
SpO_2 < 92%	• Stop infusion. • Administer high flow O_2 by face mask immediately. • Call Acute Pain Service CNSp/ANP(c) CHI at Crumlin Bleep 8300/8200, CHI at Temple street Bleep 830 • or Anaesthesiology Registrar on call – CHI at Crumlin Bleep 8528, CHI at Temple street Bleep 762 - if out of hours. • If SpO2 continues to drop call 2222 and follow resuscitation guidelines.
Pain score ≥ 4	• Call Acute Pain Service CNSp/ANP(c) CHI at Crumlin Bleep 8300/8200, CHI at Temple street Bleep 830 • or Anaesthesiology Registrar on call – CHI at Crumlin Bleep 8528, CHI at Temple street Bleep 762 - if out of hours.
Nausea score = 2	• 0 = None • 1 = Nausea only • 2 = Vomiting • Consult anaesthesiology team & consider ondansetron IV
Failure to pass urine	• Call Acute Pain Service CNSp/ANP(c) CHI at Crumlin Bleep 8300/8200, CHI at Temple street Bleep 830 • or Anaesthesiology Registrar on call – CHI at Crumlin Bleep 8528, CHI at Temple street Bleep 762 - if out of hours.
Displaying signs of hallucinations, nightmares or dysphoria	• Call Acute Pain Service CNSp/ANP(c) CHI at Crumlin Bleep 8300/8200, CHI at Temple street Bleep 830 • or Anaesthesiology Registrar on call – CHI at Crumlin Bleep 8528, CHI at Temple street Bleep 762 - if out of hours. • If dysphoria is problematic or distressing, the infusion rate may need to be reduced or the infusion ceased. • Benzodiazepines should be used with extreme caution.

7.5 Ceasing the Ketamine Infusion

a. The decision to cease the ketamine infusion should be made in consultation with Acute Pain team/ Consultant Anaesthesiologist.
b. When ketamine is being used in conjunction with opioid infusions, ketamine infusion should be discontinued first. May be discussed with Acute Pain team/ Consultant Anaesthesiologist.
c. The dose of ketamine can be reduced very gradually once clinically appropriate.
d. Other analgesics may need to be prescribed.
e. To ensure no residual ketamine remains in the line, flush IV cannula/octopus with 0.9% w/v Sodium chloride and document this on IV Fluid balance sheet/relevant care plans/care bundles.
f. Any remaining ketamine infusion must be disposed of as per local policy.

8.0 Glossary of Acronyms, Terms and Definitions

Advanced Nurse Practitioner/Candidate	ANP(c)
Alert/ Verbal/ Pain/ Unresponsive	AVPU
Children's Health Ireland	CHI
Clinical Nurse Specialist	CNSp
Intravenous	IV
Micrograms	mCg
N-Methyl-D-Aspartic Acid	NMDA
Non-Consultant Hospital Doctors	NCHDs
Non-steroidal Anti-inflammatory Drug	NSAID
Paediatric Intensive care Unit	PICU
Patient/Nurse Controlled Analgesia	P/NCA
Post-anaesthetic Care Unit	PACU
Standard Concentration Infusion	SCI
Standard Operation Procedure	SOP
Summary Of Product Characteristics	SPC

9.0 Monitoring, Audit and Evaluation

- Adherence to this guideline will be monitored by the Pain service.
- Incident reports involving IV Ketamine infusions will be monitored and reports will be responded to when they occur as per CHI medication policy.
- Required changes in practice will be identified and actioned within 1 month. A lead member of the pain service will be identified to take change forward where appropriate.
- Lessons will be shared with all the relevant stakeholders.

This PPPG will be initially reviewed at six months and updated at least every three years by the document author/owner, or earlier if required due to updated guidance, evidence or legislation. Compliance with key principles or procedures described within this PPPG should be audited on an annual basis by the author/ owner or their nominated representative.

10.0 Key stakeholders

The following key stakeholders were involved in developing and/or reviewing this document:

Name	Title	Department
Geraldine Murray	RANP Children's Pain	Pain service, CHI at Temple Street
Sarah Flaherty	RANP Children's Pain	Pain service, CHI at Crumlin
Dr Kay O' Brien	Consultant Anaesthesiologist	Pain service, CHI at Temple Street
Dr Jacinta McGinley	Consultant Anaesthesiologist	Pain service, CHI at Crumlin
Patricia Cummins	Senior Pharmacist, Theatre	CHI at Crumlin
Dr Robert Ghent	Consultant Anaesthesiologist	CHI at Crumlin
Dr Conor Hensey	Consultant Paediatrician	CHI at Temple Street
Fionnuala O'Neill	Nurse Practice Development	CHI at Crumlin
Siobhan Gilboy	Nurse Practice Development	CHI at Temple Street
Warren O'Brien	Nurse Practice Development	CHI at Crumlin
Eimear McGrath	CNEF (Informatics/Smart-Pumps)	CHI at Crumlin
Moninne Howlett	Chief Pharmacy Information Officer	CHI
Sharon Sutton	Senior Pharmacist (Smart-pumps)	CHI at Crumlin
Michael Curtin	Senior Pharmacist, PICU	CHI at Temple Street
Anne Fitzpatrick	Senior Pharmacist	CHI at Crumlin
Karen Lavelle	Medication Safety Officer	CHI
Michael Fitzpatrick	Head of Pharmacy Services	CHI

11.0 Communication and training

All approved SOP and PPPGs will be available on the Qpulse system in CHI Temple Street. In CHI Crumlin, it is available in the Intranet under Medicines Information/Medication SOP'S & Guidelines OR Nurse Practice Development Unit/Guidelines. Heads of Department and Line Managers must ensure that their staff are aware of all PPPGs relevant to their role and have access to same. Where required, training should be provided on the contents of this PPPG. Please contact Pain ANP/CNS team to receive training on nursing considerations. Contact pump.training@olchc.ie to book a pump training session.

12.0 References

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Schwenk, E.S., Viscusi, E.R., Buvanendran, A., Hurley, R.W., Wasan, A.D., Narouze, S., Bhatia, A., Davis, F.N., Hooten, W.M. and Cohen, S.P., (2018) Consensus Guidelines on the Use of Intravenous Ketamine Infusions for Acute Pain Management From the American Society of Regional Anesthesia and Pain Medicine, the American Academy of Pain Medicine, and the American Society of Anesthesiologists. *Regional Anesthesia and Pain Medicine*, 43(5), pp. 456-466.

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Sheehy, K.A., Muller, E.A., Lippold, C., Nouraie, M., Finkel, J.C. and Quezado, Z.M., (2015) Subanesthetic ketamine infusions for the treatment of children and adolescents with chronic pain: a longitudinal study. *BMC Pediatrics,* 1(15), pp. 198.

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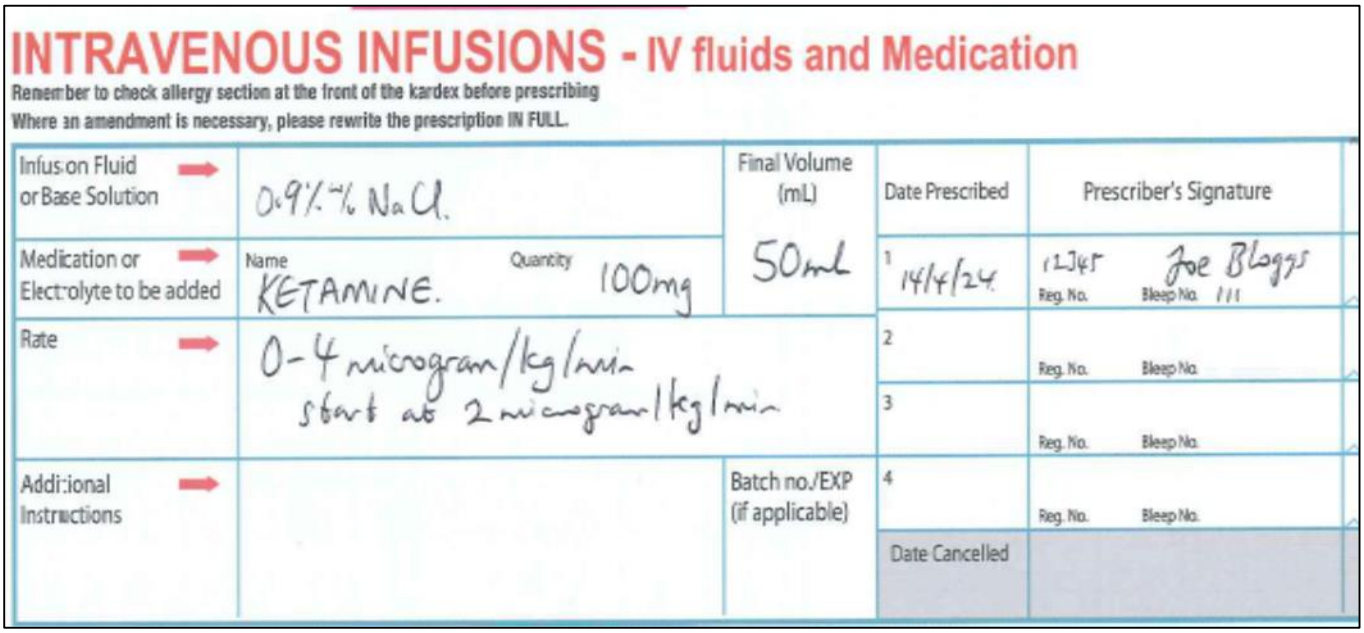
14.0 Appendices

Appendix 1: Model Prescription



INTRAVENOUS INFUSIONS - IV fluids and Medication

Remember to check allergy section at the front of the kardex before prescribing
Where an amendment is necessary, please rewrite the prescription IN FULL.

Infusion Fluid or Base Solution →	0.9% NaCl.	Final Volume (mL)	Date Prescribed	Prescriber's Signature
Medication or Electrolyte to be added →	Name KETAMINE. Quantity 100mg	50mL	1 14/4/24	12345 Joe Bloggs Reg. No. Bleep No. 111
Rate →	0-4 microgram/kg/min start at 2 microgram/kg/min		2	Reg. No. Bleep No.
			3	Reg. No. Bleep No.
Additional Instructions →		Batch no./EXP (if applicable)	4	Reg. No. Bleep No.
			Date Cancelled	

Appendix 2: CHI Ketamine Infusion Monitoring Sheet

Intravenous Ketamine Infusion Monitoring sheet

(Use in conjunction with PEWS documentation)

Full Name: .....

Address:

Date	Time HH:MM	SpO2 %	RR /min	Pain Score		Nausea Score 0 = None 1 = Nausea only 2 = Vomiting	AVPU Alert • Voice • Pain • Unresponsive	Infusion Rate mCg/kg/min	Total drug amount infused	Syringe Volume (must read from syringe) (mL)
				Moving	Resting					

FOR URGENT ADVICE CONTACT PAIN NURSE SPECIALIST or ANAESTHESIOLOGIST on-call. STOP INFUSION & CONTACT ANAESTHESIOLOGIST ON CALL if patient is unarousable, in severe pain, SpO2 < 90%, respiration rate < 10 if over 5 years or < 20 if under 5 years, excessive vomiting.

Developed by the Pain Service – 17.04.23

Appendix 3: CHI Nurse Competency Assessment Tool for Arcomed Pump

Sláinte Leanaí Éireann
CHI
Children's Health Ireland

Assessment of Competency in the Nursing Management of a Patient Requiring Patient/Nurse Controlled Analgesia

Cardiac SERVICES

Objectives	To demonstrate the ability and knowledge to safely manage Patient/Nurse Controlled Analgesia (P/NCA) using Arcomed SP6000 Infusion Pump
Competence requirements	1. Attendance at local intravenous study day 2. Supervised practice 3. Practical demonstration of setup
Re-assessment	1. If there is a break in service for more than one year, reassessment must take place on return to workplace 2. If staff identify lack of competency due to lack of exposure to use
Assessor	Registered Staff Nurse with competency in managing patients requiring and receiving P/NCA infusions via Cardiac Services Arcomed SP6000 Infusion Pump.

Step 1: Competency Assessment Tool: Arcomed SP6000 Infusion Pump

Instructions for completion: following your pump training, please indicate with a tick ✓ that you can perform the skills listed. Once you have obtained all skills, please process to **Step 2: Competency Assessment Tool: Practical Assessment.**
Note: the pump may only be used for training purposes until all below criteria is achieved.

Please demonstrate the following skills:	Skill obtained (✓)
Device Overview	
Locate and Identify the following elements:	
• AC power input	
• Pole Clamp	
• Carry handle	
• Infrared port	
• Key lock	
• On/off switch	
• Lights	
• Rate and data windows and adjustment keys	
• Start/Stop button	
• Hard and soft keys 1 & 2	
• Bolus button	
Programming pump	
• Open pump	
• Power on pump	
• Load and confirm syringe	
• Lock pump	
• Select folder and therapy	
• Input password	
• Set parameters as per prescription	
• Decrease the occlusion limit	
• Start infusion	
• Review data windows and infusion information	
Bolus function	
• Deliver bolus	
• Discuss clinician bolus function	
• Review bolus history	
Standby and power	
• Put pump into standby mode	
• Set timer in standby mode	
• Remove syringe from the pump	
• Power off the pump	

CHI Smart-Pump Team V1, April 2023