# CLINICAL GUIDELINE

# Medicines Guidelines, Intensive Care Unit, Royal Alexandra Hospital

A guideline is intended to assist healthcare professionals in the choice of disease-specific treatments.

Clinical judgement should be exercised on the applicability of any guideline, influenced by individual patient characteristics. Clinicians should be mindful of the potential for harmful polypharmacy and increased susceptibility to adverse drug reactions in patients with multiple morbidities or frailty.

If, after discussion with the patient or carer, there are good reasons for not following a guideline, it is good practice to record these and communicate them to others involved in the care of the patient.

| | |
|---|---|
| **Version Number:** | 2 |
| **Does this version include changes to clinical advice:** | Yes |
| **Date Approved:** | 26th February 2025 |
| **Date of Next Review:** | 30th April 2026 |
| **Lead Author:** | Philip Henderson |
| **Approval Group:** | Clyde Sector Clinical Governance Forum |

**Important Note**:

The online version of this document is the only version that is maintained.
Any printed copies should therefore be viewed as 'Uncontrolled' and as such, may not necessarily contain the latest updates and amendments.

# MEDICINES GUIDELINES
# INTENSIVE CARE UNIT
# ROYAL ALEXANDRA HOSPITAL

**Document navigation**

- Click on any drug in the contents section from page 2 to go directly to the correct page or drug
- Get back to the contents page from the bottom of any page by clicking: ⌂ Return to top

**Tips for Adobe PDF viewer (if using this)**

- Turn on bookmark navigation (🔖) on the left of the document to keep the navigation field open throughout
- Turn on page scrolling under: View > Page Display > Enable Scrolling
- Set zoom between 65 and 75% to optimise all pages

# Contents

Contents ..... 2
Guideline details ..... 4
Other resources: Hyperlinks ..... 5
Adrenaline: Anaphylaxis ..... 6
Adrenaline infusion: Overview ..... 7
Adrenaline: Single strength ..... 10
Adrenaline: Single strength dosing table ..... 11
Adrenaline: Double strength ..... 12
Adrenaline: Double strength dosing table ..... 13
Alfentanil bolus ..... 14
Alfentanil infusion ..... 15
Aminophyline infusion ..... 16
Anticoagulation monitoring ..... 17
Calcium replacement ..... 19
When on continuous renal replacement therapy (RRT) ..... 19
Non-RRT patients ..... 19
Clonidine ..... 21
Clonidine infusion dosing table ..... 23
Dexmedetomidine ..... 24
Dexmedetomidine infusion dosing table ..... 26
Dobutamine ..... 27
Dobutamine infusion dosing table ..... 29
Gentamicin ..... 30
Haloperidol ..... 31
Insulin ..... 33

Ketamine: Asthma & bronchospasm ..... 34
Magnesium ..... 36
Metaraminol ..... 38
Midazolam bolus ..... 40
Midazolam infusion ..... 41
Morphine bolus ..... 42
Morphine infusion ..... 43
Neuromuscular Blocking Agents (NMBA) ..... 44
Noradrenaline: Central (CVC) administration overview ..... 47
Noradrenaline: Single strength ..... 49
Noradrenaline: Single strength dosing table ..... 50
Noradrenaline: Double strength ..... 51
Noradrenaline: Double strength dosing table ..... 52
Noradrenaline: Quadruple ("Quad") strength ..... 53
Noradrenaline: Quadruple strength dosing table ..... 54
Noradrenaline: Peripheral ..... 55
Phosphate ..... 56
Potassium ..... 58
Propofol bolus ..... 60
Propofol infusion ..... 61
Salbutamol infusion (peripheral strength) ..... 62
Salbutamol infusion (CVC strength) ..... 63
Vancomycin ..... 64
Patients receiving CVVHDF ..... 64
Dose adjustment ..... 65
Vasopressin ..... 66

References and related guidelines .....67

## Guideline details

| | |
|---|---|
| **Authors** | Philip Henderson, Radha Sundaram, Fiona MacGregor, Stewart McFarlane |
| **Date published** | 1st published: April 2023; minor review March 2025 |
| **Review date** | April 2026 |
| **Objectives** | To collate pharmacy and drug information of commonly used drugs and medications for the intensive care unit (ICU) at the Royal Alexandra Hospital. |
| **Scope** | To describe the routine use of common drugs that are specific to ICU. This guideline has used available evidence, the product / manufacturers literature, alongside an evaluation of standard practice within the RAH ICU.<br><br>Where a Greater Glasgow and Clyde (GG&C), or hospital wide pharmacy or drug guideline exists this will not be repeated here and the original should be consulted in preference. |
| **Corresponding or lead author** | Philip Henderson; Tel: 0141 314 7069 (RAH ICU) |

## Other resources: Hyperlinks

- GG&C Adult Therapeutics Handbook
- Electronic medicines compendium (emc)
- British National Formulary (BNF)
- AAGBI Guidelines
- AAGBI: Quick Reference Handbook (QRH)
- Intensive Care Society Guidelines
- Adult advanced life support Guidelines
- Adult Advanced Life Support Algorithm (2021)
- Resus UK 2021 Quick Reference Handbook (QRH)
- The obese patient, anaesthesia, and drug dosing (SOBA-UK)
- Drug dosing in obese adults - PMC (nih.gov)
- Drug dosing in the critically ill obese patient
- Bodyweight calculators: Ideal and adjusted (MDCalc)

# Adrenaline: Anaphylaxis

Adrenaline is the first-line treatment for anaphylaxis. This guideline applied to adults aged ≥ 16 years old.

Immediate recognition of anaphylaxis is crucial (unexplained hypotension and / or bronchospasm may be the only features). Follow an ABC approach and administer adrenaline immediately. In critical care, in view of readily accessible intravenous access and full monitoring, administer:

**Intravenous adrenaline: 50 micrograms (0.5ml of 1 in 10,000 adrenaline)**

Usually presented as a "mini-jet" or pre-filled glass syringe in a plastic purple box; it may also be described as 1mg/10ml.

Repeat the dose if no response or short lived response.

If the patient does not have intravenous access do not delay adrenaline administration, give intramuscular adrenaline without delay:

**Intramuscular adrenaline: 0.5mg = 500 micrograms (0.5ml of 1 in 1000):** the vial will have a concentration of 1mg/ml; presented as either 5mg in 5ml OR 1mg in 1ml.

Consider starting an adrenaline infusion if the patient remains hypotensive after 3 doses of either preparation of adrenaline.

Follow AAGBI guideline for perioperative anaphylaxis:

AAGBI QRH: Anaphylaxis V5

Start CPR if no cardiac output or pulse. In this case follow the standard Advanced Life Support (ALS) algorithm and standard ALS adrenaline doses.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Adrenaline infusion: Overview

### Form

1mg/ml solution in 5ml ampoule. Total dose per ampoule is 5mg.

### Preparation

All preparations are made in 50ml syringes and infused using an infusion pump running at a rate in millilitres per hour (ml/hr). This is prepared as either “Single strength” (usual starting strength); or “Double strength”. Generally a strength is chosen to minimise syringe changes, and a pragmatic way of doing this is to choose a strength that allows the infusion rate to be established at ≤ 15ml/hr.

### Single strength (standard or starting concentration)

Dilute 4mg (4ml) with 46ml of 5% glucose. The final concentration is 80 micrograms per millilitre (80 µg/ml; can also be described as 0.08mg/ml).

### Double strength

Dilute 8mg (8ml) with 42ml of 5% glucose. The final concentration is 160 micrograms per millilitre (160 µg/ml; can also be described as 0.16mg/ml).

### Higher concentrations

Concentrations above Double strength (160 µg/ml) are generally discouraged but can be used in very exceptional circumstances after discussion with the nurse in charge and consultant in charge. In this rare situation the final concentration would be known as Quadruple “Quad” strength adrenaline and would be a concentration of 320 µg/ml.

### Administration

Central line use only, except in very exceptional circumstances.

### Dose titration

This should be guided by the clinical team and doses (in ml/hr) are generally titrated to achieve a target Mean Arterial Pressure (MAP). The main difference with adrenaline (compared to noradrenaline) is that this drug causes much more positive inotropy and chronotropy (increased cardiac output, stroke volume, and heart rate), particularly at lower doses, as well as vasoconstriction. This means occasionally the end point may not be guided by MAP and there may be other end points as guided by the senior clinical team. Be clear what the target end point is before titrating, if unsure seek senior nursing and medical input.

A starting dose of 5 to 10ml/hr is generally pragmatic, with rate increased or decreased by 0.5 to 5ml/hr depending on urgency of the clinical situation, degree of hypotension, or underlying condition causing shock. These starting doses and titration are a very rough guide and apply to single strength (80 µg/ml) Adrenaline only. Titration increments and starting doses should be altered accordingly for higher concentration infusions. A step by step guide

on titration is beyond the scope of this guideline, and those unfamiliar with titration of inotropes or vasopressors should be closely supervised by an experienced ICU nurse and / or doctor.

**Dose range**

The most precise description of an infusion rate or dose is to describe this as micrograms per kg per minute (µg/kg/min) rather than in millilitres per hour (ml/hr) which avoids the need to state which strength of drug the patient is on. This also allows better understanding when changing from one infusion concentration to another and taking into account the patient mass and size.

The standard dose is not as well defined as other inotropes or vasoactive drugs. A pragmatic approach is to consider dosing in 3 bands or groups:

1. Normal dose adrenaline: Zero to 0.2 micrograms per kg per minute (0 to ≤0.2µg/kg/min) ideal body weight;
2. High dose adrenaline: >0.2 to 0.5 micrograms per kg per minute (>0.2 to ≤0.5µg/kg/min) ideal body weight;
3. Very high dose adrenaline: >0.5 to 1.0 micrograms per kg per minute (>0.5 to 1.0µg/kg/min) ideal body weight

Doses >1µg/kg/min are extreme doses and these patients should be reviewed by the senior clinician.

**Calculating dose in micrograms per kg per minute (µg/kg/min)**

Formula:

$$Dose\ (\mu g/kg/\min) = \frac{Infusion\ rate \times infusion\ concentration}{Weight \times 60}$$

**Where:**

- Infusion rate is in millilitres per hour (ml/hr)
- Infusion concentration is the concentration in micrograms per millilitre (µg/ml) the concentrations are as follows:
    - Single strength = 80 µg/ml
    - Double strength = 160 µg/ml
    - Quadruple “Quad” strength (if used) = 320 µg/ml
- Weight is in kilograms (kg), use ideal body weight
- “60” corresponds to 60 minutes to convert µg/kg/hr to µg/kg/min

**There are infusion tables for the two main concentrations, single (here) and double (here), or under the respective sub-menus.**

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

## Adrenaline: Single strength

### Single strength (standard or starting concentration)

Dilute 4mg (4ml) of Adrenaline with 46ml of 5% glucose. The final concentration is 80 micrograms per millilitre (80 µg/ml; can also be described as 0.08mg/ml).

### Administration

Central line use only, except in very exceptional circumstances.

### Dose titration

Guided by the clinical team and doses (in ml/hr) are titrated to achieve a target Mean Arterial Pressure (MAP) in most cases, but check what the expected end point is, particularly for any patients with heart failure. A starting dose of 5 to 10ml/hr is generally pragmatic, with rate increased or decreased by 0.5 to 5ml/hr depending on urgency of the clinical situation, degree of hypotension or shock, and underlying condition causing shock. If unsure check with senior nurse or doctor.

### Dose range

Best practice is to calculate dose in micrograms per kg per minute (µg/kg/min).

No standard dose, but in the RAH, we consider the dose in 3 bands:

- Standard dose = 0 to 0.2 µg/kg/min;
- High dose = 0.21 to 0.5 µg/kg/min;
- Very high dose = 0.51 to 1.0 µg/kg/min;
- Doses above 1.0 µg/kg/min need immediate medical review

### Calculating dose in micrograms per kg per minute (µg/kg/min) for single strength (80 µg/ml)

Formula:

$$Dose\ (\mu g/kg/\min) = \frac{Infusion\ rate \times 80}{Weight \times 60}$$

**Where:**

- Infusion rate is in millilitres per hour (ml/hr)
- "80" corresponds to the infusion concentration, for single strength this is 80µg/ml
- Weight is in kg, ideal body weight
- "60" corresponds to 60 minutes to convert µg/kg/hr to µg/kg/min

# Adrenaline: Single strength dosing table

**The following table contains the infusion rates in ml/hr for a given patient weight (kg) and specific doses (µg/kg/min)**

| Adrenaline: Single strength (4mg per 50ml) Dose (µg/kg/min) | Ideal Body Weight (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| | Infusion rate (ml/hr) | | | | | | | | | | | | | |
| 0.05 | 1.3 | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 |
| 0.1 | 2.6 | 3.0 | 3.4 | 3.8 | 4.1 | 4.5 | 4.9 | 5.3 | 5.6 | 6.0 | 6.4 | 6.8 | 7.1 | 7.5 |
| 0.15 | 3.9 | 4.5 | 5.1 | 5.6 | 6.2 | 6.8 | 7.3 | 7.9 | 8.4 | 9.0 | 9.6 | 10.1 | 10.7 | 11.3 |
| 0.2 | 5.3 | 6.0 | 6.8 | 7.5 | 8.3 | 9.0 | 9.8 | 10.5 | 11.3 | 12.0 | 12.8 | 13.5 | 14.3 | 15.0 |
| 0.25 | 6.6 | 7.5 | 8.4 | 9.4 | 10.3 | 11.3 | 12.2 | 13.1 | 14.1 | 15.0 | 15.9 | 16.9 | 17.8 | 18.8 |
| 0.3 | 7.9 | 9.0 | 10.1 | 11.3 | 12.4 | 13.5 | 14.6 | 15.8 | 16.9 | 18.0 | 19.1 | 20.3 | 21.4 | 22.5 |
| 0.35 | 9.2 | 10.5 | 11.8 | 13.1 | 14.4 | 15.8 | 17.1 | 18.4 | 19.7 | 21.0 | 22.3 | 23.6 | 24.9 | 26.3 |
| 0.4 | 10.5 | 12.0 | 13.5 | 15.0 | 16.5 | 18.0 | 19.5 | 21.0 | 22.5 | 24.0 | 25.5 | 27.0 | 28.5 | 30.0 |
| 0.45 | 11.8 | 13.5 | 15.2 | 16.9 | 18.6 | 20.3 | 21.9 | 23.6 | 25.3 | 27.0 | 28.7 | 30.4 | 32.1 | 33.8 |
| 0.5 | 13.1 | 15.0 | 16.9 | 18.8 | 20.6 | 22.5 | 24.4 | 26.3 | 28.1 | 30.0 | 31.9 | 33.8 | 35.6 | 37.5 |
| 0.6 | 15.8 | 18.0 | 20.3 | 22.5 | 24.8 | 27.0 | 29.3 | 31.5 | 33.8 | 36.0 | 38.3 | 40.5 | 42.8 | 45.0 |
| 0.7 | 18.4 | 21.0 | 23.6 | 26.3 | 28.9 | 31.5 | 34.1 | 36.8 | 39.4 | 42.0 | 44.6 | 47.3 | 49.9 | 52.5 |
| 0.8 | 21.0 | 24.0 | 27.0 | 30.0 | 33.0 | 36.0 | 39.0 | 42.0 | 45.0 | 48.0 | 51.0 | 54.0 | 57.0 | 60.0 |
| 0.9 | 23.6 | 27.0 | 30.4 | 33.8 | 37.1 | 40.5 | 43.9 | 47.3 | 50.6 | 54.0 | 57.4 | 60.8 | 64.1 | 67.5 |
| 1 | 26.3 | 30.0 | 33.8 | 37.5 | 41.3 | 45.0 | 48.8 | 52.5 | 56.3 | 60.0 | 63.8 | 67.5 | 71.3 | 75.0 |

| Section authors: Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane | Date authorised: April 2023 | Review date: April 2026 |
|---|---|---|

# Adrenaline: Double strength

### Double strength (higher concentration)

Dilute 8mg (8ml) of Adrenaline with 42ml of 5% glucose. The final concentration is 160 micrograms per millilitre (160 µg/ml; can also be described as 0.16mg/ml).

### Administration

Central line use only.

### Dose titration

Guided by the clinical team and doses (in ml/hr) are titrated to achieve a target Mean Arterial Pressure (MAP) in most cases, but check what the expected end point is, particularly for any patients with heart failure. A starting dose of 2 to 10ml/hr is generally pragmatic, with rate increased or decreased by 0.5 to 2.5ml/hr depending on urgency of the clinical situation, degree of hypotension or shock, and underlying condition causing shock. If unsure check with senior nurse or doctor.

### Dose range

Best practice is to calculate dose in micrograms per kg per minute (µg/kg/min).

There is no standard dose, but in the RAH, we consider the dose in 3 bands:

- Standard dose = 0 to 0.2 µg/kg/min;
- High dose = 0.21 to 0.5 µg/kg/min;
- Very high dose = 0.51 to 1.0 µg/kg/min;
- Doses above 1.0 µg/kg/min need immediate medical review

### Calculating dose in micrograms per kg per minute (µg/kg/min) for double strength (160 µg/ml)

Formula:

$$Dose\ (\mu g/kg/\min) = \frac{Infusion\ rate \times 160}{Weight \times 60}$$

**Where:**

- Infusion rate is in millilitres per hour (ml/hr)
- "160" corresponds to the infusion concentration, for double strength this is 160µg/ml
- Weight is in kg, ideal body weight
- "60" corresponds to 60 minutes to convert µg/kg/hr to µg/kg/min

# Adrenaline: Double strength dosing table

**The following table contains the infusion rates in ml/hr for a given patient weight (kg) and specific doses (µg/kg/min)**

| Adrenaline: Double strength (8mg per 50ml) Dose (µg/kg/min) | Ideal Body Weight (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| | Infusion rate (ml/hr) | | | | | | | | | | | | | |
| 0.05 | 0.7 | 0.8 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 |
| 0.1 | 1.3 | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 |
| 0.15 | 2.0 | 2.3 | 2.5 | 2.8 | 3.1 | 3.4 | 3.7 | 3.9 | 4.2 | 4.5 | 4.8 | 5.1 | 5.3 | 5.6 |
| 0.2 | 2.6 | 3.0 | 3.4 | 3.8 | 4.1 | 4.5 | 4.9 | 5.3 | 5.6 | 6.0 | 6.4 | 6.8 | 7.1 | 7.5 |
| 0.25 | 3.3 | 3.8 | 4.2 | 4.7 | 5.2 | 5.6 | 6.1 | 6.6 | 7.0 | 7.5 | 8.0 | 8.4 | 8.9 | 9.4 |
| 0.3 | 3.9 | 4.5 | 5.1 | 5.6 | 6.2 | 6.8 | 7.3 | 7.9 | 8.4 | 9.0 | 9.6 | 10.1 | 10.7 | 11.3 |
| 0.35 | 4.6 | 5.3 | 5.9 | 6.6 | 7.2 | 7.9 | 8.5 | 9.2 | 9.8 | 10.5 | 11.2 | 11.8 | 12.5 | 13.1 |
| 0.4 | 5.3 | 6.0 | 6.8 | 7.5 | 8.3 | 9.0 | 9.8 | 10.5 | 11.3 | 12.0 | 12.8 | 13.5 | 14.3 | 15.0 |
| 0.45 | 5.9 | 6.8 | 7.6 | 8.4 | 9.3 | 10.1 | 11.0 | 11.8 | 12.7 | 13.5 | 14.3 | 15.2 | 16.0 | 16.9 |
| 0.5 | 6.6 | 7.5 | 8.4 | 9.4 | 10.3 | 11.3 | 12.2 | 13.1 | 14.1 | 15.0 | 15.9 | 16.9 | 17.8 | 18.8 |
| 0.6 | 7.9 | 9.0 | 10.1 | 11.3 | 12.4 | 13.5 | 14.6 | 15.8 | 16.9 | 18.0 | 19.1 | 20.3 | 21.4 | 22.5 |
| 0.7 | 9.2 | 10.5 | 11.8 | 13.1 | 14.4 | 15.8 | 17.1 | 18.4 | 19.7 | 21.0 | 22.3 | 23.6 | 24.9 | 26.3 |
| 0.8 | 10.5 | 12.0 | 13.5 | 15.0 | 16.5 | 18.0 | 19.5 | 21.0 | 22.5 | 24.0 | 25.5 | 27.0 | 28.5 | 30.0 |
| 0.9 | 11.8 | 13.5 | 15.2 | 16.9 | 18.6 | 20.3 | 21.9 | 23.6 | 25.3 | 27.0 | 28.7 | 30.4 | 32.1 | 33.8 |
| 1 | 13.1 | 15.0 | 16.9 | 18.8 | 20.6 | 22.5 | 24.4 | 26.3 | 28.1 | 30.0 | 31.9 | 33.8 | 35.6 | 37.5 |

| Section authors: Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane | Date authorised: April 2023 | Review date: April 2026 |
|---|---|---|

# Alfentanil bolus

For use in patients ≥16 years old.

### ICU Indications

Pain or tube intolerance in patients maintained on a continuous infusion of alfentanil.

### Adult Dose

0.5mg to 1mg IV bolus

Base initial dose on patient's:

- Age
- Weight
- Hepatic function
- Haemodynamic status
- Current infusion dose

A further bolus dose can be given after 10 minutes if required. Further bolus doses should be discussed with medical staff.

### Form

Alfentanil 25mg/50ml injection.

### Monitor patient for:

- Hypotension
- Bradycardia / tachycardia
- Delirium or agitation
- Apnoea

### Documentation

Document all bolus doses on Carevue / ICCA. Please record any adverse response to bolus doses.

| | |
|---|---|
| Section authors | Philip Henderson; Fiona MacGregor |
| Date authorised | February 2025 |
| Section review date | April 2026 |

# Alfentanil infusion

### Indication

Continuous infusion to augment sedation and / or help with endotracheal tube (ETT) tolerance in intubated patients. For the control of pain in the intubated patient. Alfentanil is of particular use when first line treatment with morphine is relatively contraindicated due to severe hepatic or renal dysfunction.

### Dose

This should be guided by the clinical team and doses are titrated, in ml/hr, to achieve the desired level of sedation, analgesia, or ETT tolerance. The usual infusion rate is between 1ml to 6ml/hr, rates above this should be reviewed by the senior clinician.

### Form

25mg/50ml vials.

### Administration

Use the 25mg/50ml vials undiluted. The  concentration is 0.5mg/ml.

### Monitoring

Monitor patient for hypotension, bradycardia / tachycardia, delirium, agitation, and apnoea.

| | |
|---|---|
| Section authors | Philip Henderson; Fiona MacGregor |
| Date authorised | February 2025 |
| Section review date | April 2026 |

# Aminophyline infusion

### Indications

As second line treatment for acute bronchospasm.

Administer a loading dose to patients who are not already on theophylline.

Use ideal body weight.

Details of loading dose and maintenance infusion (weight based) can be found here.

### Caution

Arrhythmias, hypotension, tachycardia & convulsions.

### Therapeutic drug monitoring

Desired Therapeutic range: 10 to 20mg/l

Drug monitoring / levels should be measured after 4-6 hours of starting the maintenance infusion, 6 hours after making any changes to the infusion, and daily thereafter.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

## Anticoagulation monitoring

For advice on anticoagulation and dosing please see the GG&C medicines handbook, [Link: GG&C medicines: Anticoagulants].

The most common anticoagulation used in ICU is heparin and low molecular weight heparin (LMWH). The link above outlines the options and doses. This guideline applies to the monitoring of these agents in ICU only.

### Monitoring

This can be done with Activated partial thromboplastin time ratio (APTTr) for unfractionated heparin (UFH) or anti-factor Xa levels (Anti-Xa) for LMWH. UFH dose adjustments should always be made using APTT and there should not be delays in monitoring due to waiting for results, follow the GGC guideline. Anxi-Xa levels are offered for UFH here for use at the discretion of the consultant only. The following table outlines the different agents, the optimal sampling time, and the targets for both prophylactic and treatment doses.

| | Unfractionated Heparin Infusion | Enoxaparin | Dalteparin |
|---|---|---|---|
| **Delivery** | Continuous IV infusion | Intermittent SC bolus | Intermittent SC bolus |
| **Primary monitoring test** | APTTr | Anti-Xa | Anti-Xa |
| **APTTr target range: therapeutic dosing** | 1.8 to 2.8 (Link: here) | NA | NA |
| **Anti-Xa sample timing** | Only once steady state has been established using APTTr and at the discretion of the consultant. Do not routinely use Anti-Xa to adjust doses. | 4 hours after any dose from the 3rd dose onwards. | 4 hours after any dose from the 3rd dose onwards. |
| **Anti-Xa target range: prophylactic dosing** | NA | 0.1 to 0.4 | 0.1 to 0.4 |
| **Anti-Xa target range: therapeutic dosing** | *** 0.3 to 0.7 *** | 0.5 to 1.2 | 0.5 to 1.2 |

*** It is of critical importance that Anti-Xa is only used in specific circumstances for UFH and that routine dose adjustment should follow the GGC protocol. ***

References:

Vandiver JW, Vondracek TG. Antifactor Xa levels versus activated partial thromboplastin time for monitoring unfractionated heparin. Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy. 2012 Jun;32(6):546-58.

Measurement of non-Coumarin anticoagulants and their effects on tests of Haemostasis: Guidance from the British Committee for Standards in Haematology (wiley.com)

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Calcium replacement

## When on continuous renal replacement therapy (RRT)

**Replace before commencement of continuous renal replacement therapy (CRRT) if ionised calcium under 1mmol/l**

Dose:

- Add 10ml Calcium Chloride 14.7% (10mmol) to 50ml of 0.9% sodium chloride and administer over 20 minutes via syringe driver into the CVC or a large peripheral vein with ECG monitoring.
- Second line if above unavailable: add 40ml Calcium Gluconate 10% (9mmol) to 200ml of 5% glucose and give over 20 minutes into the CVC or a large peripheral vein with ECG monitoring.

## Non-RRT patients

Routine replacement for hypocalcaemia is not recommended. If considering replacement for asymptomatic hypocalcaemia please discuss with the consultant in charge.

If replacement being undertaken, preferentially use the GG&C wide guideline for replacing calcium using a larger volume infusion over 24 hours or enteral replacement (nasogastric/oral) replacement:

GG&C Medicines: Management of Hypocalcaemia

**Absolute Indications**

- Hyperkalaemia (K >6.5mmol/L and /or ECG changes)
- Drug induced QT prolongation and torsades de pointes with co-existing hypocalcaemia
- Correction of acute severe hypocalcaemia (ionised calcium <1 mmol/l) with clinical signs of tetany

**Relative Indications**

- Massive blood transfusion
- Coagulopathy
- Refractory shock

**Form**

Calcium Gluconate 10% injection (1g / 2.2mmol calcium in 10ml)

### Adult Dose & administration

Add 10ml calcium gluconate 10% (2.2mmol) to 50ml of 0.9% sodium chloride and administer over 15 - 20mins via syringe driver into the CVC or a large peripheral vein with ECG monitoring.

This is a deviation from practice recommended in the GGC Adult Therapeutics Handbook for the purpose of myocardial stabilisation during correction of hyperkalemia because the intravenous administration via a pump is safer in a critical care area.

### Monitoring

- Continuous ECG monitoring essential
- Check serum calcium 2 hours post infusion
- Check serum magnesium

### Cautions

- Renal calculi: these patients should have calcium replacement in larger fluid volumes
- Digoxin toxicity or patients on digoxin: increased risk of arrhythmias
- Acute severe hyperphosphataemia: requires treatment before IV calcium is administered
- Do not administer simultaneously with ceftriaxone even through a different line

### Adverse Effects

- Severe venous irritation
- Vasodilatation
- Hot flushes
- Hypotension
- Bradycardia
- Cardiac arrhythmias
- Syncope
- Cardiac arrest
- Extravasation: can cause tissue necrosis, give via CVC preferably or a large peripheral vein
- Hypercalcaemia

### Section references


1. Forsythe ,Wessel et al .Parenteral Calcium for Intensive Care Unit patients. Cochrane Database Systematic Reviews. Parenteral calcium for intensive care unit patients - PubMed (nih.gov).
2. Steele et al. Assessment and clinical course of hypocalcemia in critical illness. Critical Care 2013. https://doi.org/10.1186/cc12756


| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Clonidine

### ICU Indications

- Agitated delirium
- Management of opiate or alcohol withdrawal
- Utilisation of the sedative, analgesic, and opioid-sparing properties of clonidine

### Adult Dose

Intermittent dosing

- 50 micrograms to 150 micrograms three times per day intravenously or via nasogastric tube
- If doses > 150 micrograms three times per day are required then consider continuous infusion

### Continuous infusion

Usual dose 0.5 to 2 µg/kg/hr (micrograms per kg per hour)

Sudden cessation of clonidine can cause a withdrawal syndrome leading to rebound hypertension, headache, flushing, sweating, agitation, and nausea. If the patient has been on high dose clonidine for several days then consider tapering the dose over 2 to 4 days.

### Form

150 micrograms / 1ml ampoules

### Administration

Clonidine can be administered either centrally or peripherally.

### Intermittent dosing

**IV:** Give prescribed dose in 50-100ml 0.9% Sodium Chloride or 5% Glucose over 15-30mins.

**Enteral:** crush the tablets and disperse in water to administer via nasogastric tube. The injection preparation can also be used enterally and given neat.

### Preparation (continuous infusion)

Dilute 750 micrograms (5 ampoules of 150 micrograms/ml) with 45ml of 5% Glucose; resultant concentration is 15 µg/ml (micrograms per millilitre).

### Monitoring

- Blood pressure and heart rate: clonidine can cause hypotension and bradycardia
- Monitor for withdrawal syndrome if stopped suddenly

### Cautions

- Bradycardia
- AV block or sick sinus syndrome (contraindicated)
- Low cardiac output or impaired left ventricular function
- Raynauds or peripheral occlusive disorder
- Renal impairment (may accumulate)

### Adverse Effects

- Bradycardia
- AV block
- Hypotension
- Headache
- Hallucinations
- Constipation
- Paralytic Ileus (in combination with high dose opioids)

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Clonidine infusion dosing table

**The following table contains the infusion rates in ml/hr for a given patient weight (kg) and specific doses (µg/kg/hr)**

| Clonidine (15µg/ml) | Dose (µg/kg/hr) | Actual body weight (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | ≥100 |
| | | Infusion rate (ml/hr) | | | | | | | | | | | | | |
| | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 |
| | 0.2 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 1.1 | 1.1 | 1.2 | 1.3 | 1.3 |
| | 0.3 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 |
| | 0.4 | 0.9 | 1.1 | 1.2 | 1.3 | 1.5 | 1.6 | 1.7 | 1.9 | 2.0 | 2.1 | 2.3 | 2.4 | 2.5 | 2.7 |
| | 0.5 | 1.2 | 1.3 | 1.5 | 1.7 | 1.8 | 2.0 | 2.2 | 2.3 | 2.5 | 2.7 | 2.8 | 3.0 | 3.2 | 3.3 |
| | 0.6 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 | 4.0 |
| | 0.7 | 1.6 | 1.9 | 2.1 | 2.3 | 2.6 | 2.8 | 3.0 | 3.3 | 3.5 | 3.7 | 4.0 | 4.2 | 4.4 | 4.7 |
| | 0.8 | 1.9 | 2.1 | 2.4 | 2.7 | 2.9 | 3.2 | 3.5 | 3.7 | 4.0 | 4.3 | 4.5 | 4.8 | 5.1 | 5.3 |
| | 0.9 | 2.1 | 2.4 | 2.7 | 3.0 | 3.3 | 3.6 | 3.9 | 4.2 | 4.5 | 4.8 | 5.1 | 5.4 | 5.7 | 6.0 |
| | 1 | 2.3 | 2.7 | 3.0 | 3.3 | 3.7 | 4.0 | 4.3 | 4.7 | 5.0 | 5.3 | 5.7 | 6.0 | 6.3 | 6.7 |
| | 1.2 | 2.8 | 3.2 | 3.6 | 4.0 | 4.4 | 4.8 | 5.2 | 5.6 | 6.0 | 6.4 | 6.8 | 7.2 | 7.6 | 8.0 |
| | 1.4 | 3.3 | 3.7 | 4.2 | 4.7 | 5.1 | 5.6 | 6.1 | 6.5 | 7.0 | 7.5 | 7.9 | 8.4 | 8.9 | 9.3 |
| | 1.6 | 3.7 | 4.3 | 4.8 | 5.3 | 5.9 | 6.4 | 6.9 | 7.5 | 8.0 | 8.5 | 9.1 | 9.6 | 10.1 | 10.7 |
| | 1.8 | 4.2 | 4.8 | 5.4 | 6.0 | 6.6 | 7.2 | 7.8 | 8.4 | 9.0 | 9.6 | 10.2 | 10.8 | 11.4 | 12.0 |
| | 2 | 4.7 | 5.3 | 6.0 | 6.7 | 7.3 | 8.0 | 8.7 | 9.3 | 10.0 | 10.7 | 11.3 | 12.0 | 12.7 | 13.3 |

0.5µg/kg/hr is the usual starting dose

| Section authors: Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane | Date authorised: April 2023 | Review date: April 2026 |
|---|---|---|

# Dexmedetomidine

### Form

Dexmedetomidine 400 micrograms / 4ml injection.

### Indication

Sedation / anxiolysis in patients:

- Whose sedative requirement is challenging to manage
- Prior to extubation where a lack of respiratory depression may be helpful
- On non-invasive ventilation
- As part of a multimodal technique when avoiding propofol when propofol infusion syndrome is suspected

### Dose

0.4 to 1.4 µg/kg/hour (micrograms per kg per hour)

Start at an initial dose of 0.4 µg/kg/hour. Higher initial doses may be required in patients who are very agitated.

Dose titration should be tailored for each individual patient.

Allow 30-60 minutes between dose changes.

Do not administer a loading dose or bolus dose.

The maximum dose of 1.4 µg/kg/hour should not be exceeded.

Dexmedetomidine is metabolised in the liver. A reduced dose may be considered in patients with hepatic impairment.

### Preparation

Dilute 2 x 400 micrograms per 4ml (400µg / 4ml) vials with 92ml of 5% Glucose; the resultant concentration 8µg/ml (micrograms per millilitre).

### Monitor for:

- Hypotension
- Hypertension
- Bradycardia
- Hyperthermia

Withdrawal reactions can occur when stopped abruptly after prolonged use. This should be considered if the patient develops agitation or hypertension.

### Cautions

- Second or third degree AV block (contraindicated)
- Hypotension
- Cerebrovascular disease
- Bradycardia
- Spinal cord injury
- Malignant hyperthermia

### Adverse Effects

- Bradycardia
- Tachycardia
- Myocardial ischaemia / infarction
- Hypotension
- Agitation
- Hyperthermia
- Nausea / Vomiting

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Dexmedetomidine infusion dosing table

**The following table contains the infusion rates in ml/hr for a given patient weight (kg) and specific doses (µg/kg/hr)**

| Dexmedetomidine (8µg/ml) Dose (µg/kg/hr) | Actual body weight (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | ≥100 |
| | Infusion rate (ml/hr) | | | | | | | | | | | | | |
| **0.1** | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 | 1.0 | 1.1 | 1.1 | 1.2 | 1.3 |
| **0.2** | 0.9 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.6 | 1.8 | 1.9 | 2.0 | 2.1 | 2.3 | 2.4 | 2.5 |
| **0.3** | 1.3 | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 |
| **0.4** | 1.8 | 2.0 | 2.3 | 2.5 | 2.8 | 3.0 | 3.3 | 3.5 | 3.8 | 4.0 | 4.3 | 4.5 | 4.8 | 5.0 |
| **0.5** | 2.2 | 2.5 | 2.8 | 3.1 | 3.4 | 3.8 | 4.1 | 4.4 | 4.7 | 5.0 | 5.3 | 5.6 | 5.9 | 6.3 |
| **0.6** | 2.6 | 3.0 | 3.4 | 3.8 | 4.1 | 4.5 | 4.9 | 5.3 | 5.6 | 6.0 | 6.4 | 6.8 | 7.1 | 7.5 |
| **0.7** | 3.1 | 3.5 | 3.9 | 4.4 | 4.8 | 5.3 | 5.7 | 6.1 | 6.6 | 7.0 | 7.4 | 7.9 | 8.3 | 8.8 |
| **0.8** | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| **0.9** | 3.9 | 4.5 | 5.1 | 5.6 | 6.2 | 6.8 | 7.3 | 7.9 | 8.4 | 9.0 | 9.6 | 10.1 | 10.7 | 11.3 |
| **1** | 4.4 | 5.0 | 5.6 | 6.3 | 6.9 | 7.5 | 8.1 | 8.8 | 9.4 | 10.0 | 10.6 | 11.3 | 11.9 | 12.5 |
| **1.1** | 4.8 | 5.5 | 6.2 | 6.9 | 7.6 | 8.3 | 8.9 | 9.6 | 10.3 | 11.0 | 11.7 | 12.4 | 13.1 | 13.8 |
| **1.2** | 5.3 | 6.0 | 6.8 | 7.5 | 8.3 | 9.0 | 9.8 | 10.5 | 11.3 | 12.0 | 12.8 | 13.5 | 14.3 | 15.0 |
| **1.3** | 5.7 | 6.5 | 7.3 | 8.1 | 8.9 | 9.8 | 10.6 | 11.4 | 12.2 | 13.0 | 13.8 | 14.6 | 15.4 | 16.3 |
| **1.4** | 6.1 | 7.0 | 7.9 | 8.8 | 9.6 | 10.5 | 11.4 | 12.3 | 13.1 | 14.0 | 14.9 | 15.8 | 16.6 | 17.5 |

0.4µg/kg/hr is the usual starting dose

| Section authors: Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane | Date authorised: April 2023 | Review date: April 2026 |
|---|---|---|

# Dobutamine

### Form

Usually presented as 5mg/ml solution in 50 ml ampoule. Total dose per ampoule is 250mg.

### Preparation

Draw up the neat solution into a 50ml syringe.

If a different concentration is available (e.g. 12.5mg/ml), then 250mg of Dobutamine should be diluted with 0.9% sodium chloride or 5% glucose to a total volume of 50ml. This final concentration should always be 5mg/ml (which can also be written as: 250mg/50ml).

### Administration

Central line use only, except in very exceptional circumstances

### Dose range

The most precise description of an infusion rate or dose is to describe this as micrograms per kg per minute (µg/kg/min) rather than in millilitres per hour (ml/hr). Use Ideal Body Weight (IBW) which can be calculated here or taken from the ICU electronic notes system (Careview or ICCA).

The usual starting dose is: 5 µg/kg/min

The usual maximum dose is: 15 µg/kg/min

At high doses tachycardia, arrhythmias, and hypotension (from vasodilatation) can become problematic.

### Calculating dose: when the rate in ml/hr is known

The dose should be calculated in micrograms per kg per minute (µg/kg/min) to accurately represent a body weight corrected dose. The formula is:

$$Dose\ (\mu g/kg/\min) = \frac{Infusion\ rate \times 5000}{Weight \times 60}$$

An alternative, simpler and quick calculation is to use:

$$Dose\ (\mu g/kg/\min) = \frac{Infusion\ rate \times 83.3}{Weight}$$

### Where

Infusion rate is in ml/hr; weight is ideal body weight in kg.

**Calculating infusion rate: where the dose in µg/kg/min is known**

If starting at a specific dose, usually expressed in µg/kg/min, the following equation should be used:

$$Infusion\ rate\ (ml/hr\ ) = \frac{Dose\ x\ weight\ x\ 60}{5000}$$

**Where**

Dose is in µg/kg/min; weight is ideal body weight in kg.

An infusion table is on the next page or click here

# Dobutamine infusion dosing table

**The following table contains the infusion rates in ml/hr for a given patient weight (kg) and specific doses (µg/kg/min)**

| Dobutamine (250mg per 50ml; 5mg/ml) | Dose (µg/kg/min) | Ideal Body Weight (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| | | Infusion rate (ml/hr) | | | | | | | | | | | | | |
| | 1 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 | 0.8 | 0.8 | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 |
| | 1.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 |
| | 2 | 0.8 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.2 | 2.3 | 2.4 |
| | 2.5 | 1.1 | 1.2 | 1.4 | 1.5 | 1.7 | 1.8 | 2.0 | 2.1 | 2.3 | 2.4 | 2.6 | 2.7 | 2.9 | 3.0 |
| | 3 | 1.3 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.3 | 2.5 | 2.7 | 2.9 | 3.1 | 3.2 | 3.4 | 3.6 |
| | 3.5 | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.5 | 2.7 | 2.9 | 3.2 | 3.4 | 3.6 | 3.8 | 4.0 | 4.2 |
| | 4 | 1.7 | 1.9 | 2.2 | 2.4 | 2.6 | 2.9 | 3.1 | 3.4 | 3.6 | 3.8 | 4.1 | 4.3 | 4.6 | 4.8 |
| | 4.5 | 1.9 | 2.2 | 2.4 | 2.7 | 3.0 | 3.2 | 3.5 | 3.8 | 4.1 | 4.3 | 4.6 | 4.9 | 5.1 | 5.4 |
| | 5 | 2.1 | 2.4 | 2.7 | 3.0 | 3.3 | 3.6 | 3.9 | 4.2 | 4.5 | 4.8 | 5.1 | 5.4 | 5.7 | 6.0 |
| | 6 | 2.5 | 2.9 | 3.2 | 3.6 | 4.0 | 4.3 | 4.7 | 5.0 | 5.4 | 5.8 | 6.1 | 6.5 | 6.8 | 7.2 |
| | 7 | 2.9 | 3.4 | 3.8 | 4.2 | 4.6 | 5.0 | 5.5 | 5.9 | 6.3 | 6.7 | 7.1 | 7.6 | 8.0 | 8.4 |
| | 8 | 3.4 | 3.8 | 4.3 | 4.8 | 5.3 | 5.8 | 6.2 | 6.7 | 7.2 | 7.7 | 8.2 | 8.6 | 9.1 | 9.6 |
| | 9 | 3.8 | 4.3 | 4.9 | 5.4 | 5.9 | 6.5 | 7.0 | 7.6 | 8.1 | 8.6 | 9.2 | 9.7 | 10.3 | 10.8 |
| | 10 | 4.2 | 4.8 | 5.4 | 6.0 | 6.6 | 7.2 | 7.8 | 8.4 | 9.0 | 9.6 | 10.2 | 10.8 | 11.4 | 12.0 |
| | 11 | 4.6 | 5.3 | 5.9 | 6.6 | 7.3 | 7.9 | 8.6 | 9.2 | 9.9 | 10.6 | 11.2 | 11.9 | 12.5 | 13.2 |
| | 12 | 5.0 | 5.8 | 6.5 | 7.2 | 7.9 | 8.6 | 9.4 | 10.1 | 10.8 | 11.5 | 12.2 | 13.0 | 13.7 | 14.4 |
| | 13 | 5.5 | 6.2 | 7.0 | 7.8 | 8.6 | 9.4 | 10.1 | 10.9 | 11.7 | 12.5 | 13.3 | 14.0 | 14.8 | 15.6 |
| | 14 | 5.9 | 6.7 | 7.6 | 8.4 | 9.2 | 10.1 | 10.9 | 11.8 | 12.6 | 13.4 | 14.3 | 15.1 | 16.0 | 16.8 |
| | 15 | 6.3 | 7.2 | 8.1 | 9.0 | 9.9 | 10.8 | 11.7 | 12.6 | 13.5 | 14.4 | 15.3 | 16.2 | 17.1 | 18.0 |
| | | 5 µg/kg/min is the usual starting dose | | | | | | | | | | | | | |

| Section authors: Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane | Date authorised: April 2023 | Review date: April 2026 |
|---|---|---|

# Gentamicin

Follow NHS GG&C guidance when prescribing and administering gentamicin. This can be accessed here

Creatinine clearance calculation link: GG&C Medicines: Height, Weights, and CrCl

Gentamicin calculator creatinine clearance link: GG&C Gentamicin CrCl calculator

### Patients receiving Continuous Veno-Veno Haemodiafiltration (CVVHDF)

- Give 2.5mg/kg up to a maximum of 180mg
- Take a level after 24 hours
- Do not give a further dose until the level is less than 1mg/l
- If the renal replacement therapy has stopped, wait until the level is <1mg/l and use the gentamicin calculator to calculate the next dose

**** Note that in patients with severe renal impairment and those receiving CVVHDF are at risk of under-dosing as they will be prescribed reduced doses at prolonged dose intervals. These patients should be discussed with microbiology to ensure the most appropriate antimicrobial strategy is pursued ****

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Haloperidol

### Haloperidol for the treatment of agitated delirium

Haloperidol can be used for patients who are delirious, agitated, or show evidence of psychosis.

### Preparation

A 1mg/ml solution should be prepared by diluting the injection with 5% glucose.

### Dose and administration

As required (PRN) dosing:

A starting dose of 0.5 - 5mg intravenously (IV) should be given depending on the patient's age and weight. A single dose may take up to 30 minutes to work.

Maximum daily dose should not exceed 20mg. Discuss with senior medical staff if agitated delirium persists despite maximal haloperidol therapy.

Regular dosing:

The usual starting dose is 2.5mg three times per day.

Doses can be titrated depending on patient's age and weight with a range of 0.5 to 2.5mg up to four times per day.

#### Complications

The main known complications of haloperidol use are:

1. QT / QTc prolongation
2. Extrapyramidal side effects
3. Convulsions from reduction in seizure threshold
4. Hypotension

### QT / QTc prolongation

Haloperidol can cause a dose dependent QT / QTc prolongation. This occurs more commonly with IV administration than with enteral administration. A 12 lead ECG should, therefore, be performed prior to treatment and once regular dosing has been established. Serum magnesium and potassium should be monitored and replaced as required.

Haloperidol should not be used in patients with a history of prolonged QT due to the risk of ventricular arrhythmias and should be used with caution in combination with other drugs which prolong the QT / QTc. Reduce the haloperidol dose or discontinue if QTc prolongation occurs during treatment (QTc > 500 msec or 25% greater than previous ECG readings).

The following drugs can prolong the QTc interval and are frequently used in ICU:

- Amiodarone
- Clarithromycin
- Metoclopramide
- Methadone
- Ondansetron

### Extrapyramidal effects

Extrapyramidal effects include:

- Tremor
- Rigidity
- Hypersalivation
- Bradykinesia
- Akathisia
- Acute dystonia
- Tardive dyskinesia

Procyclidine may be used to treat extrapyramidal side effects. In an emergency, 5 - 10mg IV should provide relief within 5 to 10 minutes.

### Reduced seizure threshold

Haloperidol lowers the seizure threshold. There is an increased risk of convulsions when haloperidol is given with tramadol.

### Hypotension

Hypotension may occur. If this is thought to be due to haloperidol, the drug should be discontinued, or dose reduced. This should be discussed with the consultant in charge.

| | |
|---|---|
| Section authors | Philip Henderson; Fiona MacGregor |
| Date authorised | February 2025 |
| Section review date | April 2026 |

## Insulin

Please see insulin and glycaemic control protocols from the critical guideline platform available here.

# Ketamine: Asthma & bronchospasm

The following guideline is for the use of ketamine in asthma or bronchospasm. This guideline does not describe ketamine for analgesia. To use ketamine for the treatment of pain please discuss with the ICU consultant and pharmacist.

### Indications

For use only in patients ≥16 years.

For use in patients with acute severe asthma or bronchospasm not responding to standard therapy.

### Dose

0.5mg/kg intravenous bolus over at least 1 minute followed by 0.5mg/kg/hour continuous intravenous infusion.

Ketamine infusion should be reviewed by a consultant on a daily basis.

### Form

Ketamine is available in multiple preparations. In ICU the two most common preparations are:

- 50mg/ml injection (500mg/10ml vial)
- 10mg/ml injection (50mg/5ml ampoule)

### Administration

Ketamine can be administered by intravenous infusion either centrally or peripherally.

The concentration for infusion should always be 10mg/ml.

If using the 50mg/ml vial dilute 10ml with 40ml 5% Glucose or 0.9% Sodium Chloride, resultant concentration 10mg/ml.

If using the 10mg/ml ampoule use this preparation neat, 500mg in 50ml (10 ampoules).

**The following table outlines suggested doses per weight:**

| | | Actual body weight (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| Ketamine (10mg/ml) | Bolus dose (ml) | 1.8 | 2.0 | 2.3 | 2.5 | 2.8 | 3.0 | 3.3 | 3.5 | 3.8 | 4.0 | 4.3 | 4.5 | 4.8 | 5.0 |
| | Maintenance infusion (ml/hr) | 1.8 | 2.0 | 2.3 | 2.5 | 2.8 | 3.0 | 3.3 | 3.5 | 3.8 | 4.0 | 4.3 | 4.5 | 4.8 | 5.0 |

### Monitoring

**Psychotic side effects:** ketamine can cause hallucinations; nightmares; and transient psychotic side effects. A background infusion of propofol or midazolam should minimise these effects.

**Blood pressure and heart rate:** Ketamine enhances the release of catecholamines and may raise blood pressure and heart rate.

### Cautions

- Hypertension
- Predisposition to seizures
- Psychotic disorders
- Cardiac disease
- Raised intracranial pressure

### Adverse Effects

- Tachycardia
- Hypertension
- Rash
- Arrhythmias
- Hypersalivation

### Other

There is little information on compatibilities with ketamine, therefore, it is advisable to administer alone when possible.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Magnesium

### ICU Indications

1. Correction of hypomagnesaemia (normal range 0.70-1.00mmol/L)
2. Arrhythmias
3. Asthma
4. Eclampsia

### Adult Dose

Correction of hypomagnesaemia: 20mmol (5g)

Arrhythmias: 8 mmol (2g)

Asthma: 8mmol (2g)

Eclampsia: For guidance on dosage and administration of magnesium sulphate in eclampsia please refer to the obstetric guidelines through the GGC clinical guideline platform [LINK: Hypertension in pregnancy guideline; All obstetric guidelines are available via the link: Obstetrics guidelines GG&C]

### Presentation

Magnesium sulphate 1g is equivalent to 4mmol magnesium.

This is presented as magnesium sulphate injection 50% ampoules (2mmol/ml). This is equivalent to 0.5g/ml.

### Administration

Correction of hypomagnesaemia: Dilute 20mmol (5g) to 100ml with 5% glucose or normal saline (0.9% NaCl) and infuse over 3 hours via peripheral or central line.

Arrhythmias: Dilute 8 mmol (2g) to 10ml with 5% glucose or normal saline and give over 10-15 minutes (repeated once if necessary) via central line if possible.

Asthma: Dilute 8mmol (2g) to 50ml with 5% glucose or normal saline and give over 20 minutes via central line if possible.

### Monitoring

- Serum magnesium
- Serum calcium
- Blood pressure
- Monitor for signs of overdose (loss of patellar reflexes, weakness, nausea, flushing, drowsiness)

### Cautions

- Use with caution in patients with myasthenia gravis
- Parenteral magnesium enhances effects of non-depolarising muscle relaxants and suxamethonium
- Dosage may need to be reduced in renal impairment

### Adverse Effects

Hypocalcaemia

Undiluted injection may cause tissue damage

Features associated with hypermagnesaemia include:

- Hypotension
- Arrhythmias
- Respiratory depression
- Drowsiness
- Loss of tendon reflexes
- Muscle weakness
- Nausea/vomiting

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Metaraminol

Metaraminol is a vasoconstrictor used for the short-term management of acute hypotension in postoperative patients and can be administered peripherally.

### Form

IV 10mg in 1ml (per ampoule)

### Preparation

| | Intravenous bolus | Infusion pump |
|---|---|---|
| **Drug starting concentration** | 10 mg / 1 ml | 10 mg / 1 ml |
| **Prescription** | 10 mg in 20 ml | 20 mg in 40 ml |
| **Diluent** | 0.9% NaCl | 0.9% NaCl |
| **Diluent volume** | 19 ml | 38 ml |
| **Volume of drug** | 1 ml (1 ampoule) | 2 ml (2 ampoules) |
| **Final concentration** | 0.5 mg/ml | 0.5 mg/ml |
| **Final volume** | 20ml | 40ml |

### Administration

Usually administered peripherally. Can be administered centrally but generally alternative medications are used if central access is present.

### Bolus dose

Dilute as above, concentration for administration is 0.5mg/ml in a 20ml syringe.

Administer 0.5mg (1ml) every 3 minutes until desired blood pressure achieved. Bolus dose can be increased to 2mg if required.

### Infusion

Dilute as above, concentration for administration is 0.5mg/ml made up into 40ml.

Administer at an infusion rate of 0 to 20ml/hr. Infusions should be used as short term treatment for hypotension for up to 24 hours maximum. If there is a prolonged need for vasopressors or rate is exceeding 20mL/hr, a central line should be considered and alternative vasopressors prescribed.

### Dose Titration

The infusion rate of metaraminol can be increased or decreased every 15 minutes by 2 to 3ml/hr to achieve the target blood pressure specified on the prescription. Changes to the rate should be documented (in ml/hr) on the chart (HDU chart or ICU carevue / ICCA system) the same as for noradrenaline.

### Dose Range

0 to 20ml/hr of a 0.5mg/ml solution

### Monitoring

- Continuous blood pressure and cardiac monitoring for the duration of the infusion.
- Monitor fluid balance.
- Monitor peripheral vein infusion site for signs of extravasation, which can cause local tissue necrosis.

### Side Effects

Headache, hypertension, arrhythmias, nausea, palpitations, and hypersensitivity reaction. May cause reduced placental perfusion in pregnancy.

### Extravasation

This medicine has a low pH and may cause venous irritation and tissue damage in cases of extravasation. If a central venous access device is unavailable, administer via a large peripheral vein monitoring insertion site closely. Re-site cannula at first signs of pain, erythema, or inflammation.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Midazolam bolus

For use in patients ≥16 years.

### ICU Indication

To treat agitation or to achieve a rapid increase in depth of sedation in patients maintained on a continuous infusion of midazolam.

### Dose

0.5mg to 2.5mg IV bolus

Base initial dose on patient's age, weight, renal, and hepatic function, haemodynamic status and current infusion dose.

A second bolus dose can be given after 10 minutes if required. Discuss any further bolus doses with medical staff.

### Form

Midazolam 1mg/ml injection.

### Monitoring

Monitor patient for hypotension, bradycardia/tachycardia, delirium, agitation, and apnoea.

### Documentation

Document all bolus doses on Carevue. Please record any adverse response to bolus doses.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Midazolam infusion

### Indication

For sedation, particularly intubated and ventilated patients. Can be used as part of a multimodal strategy especially when propofol dose reduction is required (e.g. high doses at risk of propofol infusion syndrome) or when propofol is contraindicated.

### Dose

This should be guided by the clinical team and dosed in ml/hr to achieve the desired level of sedation. The usual infusion rate is between 0.5 and 3ml/hr, rates above this should be reviewed by the senior clinician.

### Form

1mg/ml solution in 50ml vial. Total dose per vial is 50mg

### Administration

Midazolam can be administered by intravenous infusion either centrally or peripherally

The concentration for infusion should always be 1mg/ml (draw up neat)

### Monitoring

Monitor patient for hypotension, bradycardia/ tachycardia, delirium, agitation, and apnoea

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Morphine bolus

For use in patients ≥16 years.

### ICU Indication

Pain or tube tolerance in patients maintained on a continuous infusion of morphine.

### Adult Dose

0.5mg - 2mg IV bolus

Base initial dose on patient's age, weight, renal and hepatic function, haemodynamic status and current infusion dose.

A second bolus dose can be given after 10 minutes if required. Discuss any further bolus doses with medical staff.

### Form

Morphine 1mg/ml injection.

### Monitoring

Monitor patient for hypotension, bradycardia, tachycardia, delirium, agitation, and apnoea.

### Documentation

Document all bolus doses on Carevue. Please record any adverse response to bolus doses.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Morphine infusion

### Indication

To control pain and facilitate tube tolerance in the intubated patient

### Dose

This should be guided by the clinical team and dosed in ml/hr to achieve the desired level of sedation. The usual infusion rate is between 0.5 and 3ml/hr, rates above this should be reviewed by the senior clinician.

### Form

1mg/ml solution in 50ml vial. Total dose per vial is 50mg

### Administration

Morphine can be administered by intravenous infusion either centrally or peripherally

The concentration for infusion should always be 1mg/ml (draw up neat)

### Monitoring

Monitor patient for hypotension, bradycardia/tachycardia, delirium, agitation, and apnoea

### Caution

Be careful when using morphine infusions in the presence of renal impairment as accumulation may occur

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Neuromuscular Blocking Agents (NMBA)

### Indications

- As a bolus to facilitate intubation
- Treatment of severe acute respiratory failure with ARDS
- Facilitate safe ventilation in status asthmaticus
- Patient ventilator asynchrony
- Treat shivering during targeted temperature management
- Reduce ICP in patients with a head injury
- During transfers of mechanically ventilated patients
- Facilitate invasive procedures such as chest drain insertion

### Administration

Always administered neat. Can be drawn up in 5ml or 10ml syringes for bolus administration and into a 50ml luer lock syringe for continuous infusions.

### NMBA options

1. **Rocuronium:** 10mg/ml (5ml vial = 50mg). Usually first line for rapid sequence induction (RSI) as a bolus. Can be used as an infusion offering benefits over other options as rocuronium is not associated with histamine release. Reliant on hepatic and renal clearance and more likely to accumulate with prolonged infusions.
2. **Atracurium:** 10mg/ml (5ml vial = 50mg). Widely available and drug clearance is independent of renal or hepatic function, therefore unlikely to accumulate in the ICU population. For pragmatic supply issues and beneficial pharmacokinetics this is often the first line drug for continuous infusions. Can be associated with histamine release.
3. **Cisatracurium:** 2mg/ml (10ml vial = 20mg). Often not available. If available this would be the first line for infusion as is rapidly metabolised, similar to atracurium, but produces less histamine release.
4. **Suxamethonium:** 50mg/ml (2ml vial = 100mg). Can be used for RSI as a bolus either IV or IM. This is the only depolarising muscle relaxant available. Should not be used as an infusion. Suxamethonium causes a rise in serum potassium and this response is exaggerated in patients with prolonged immobility, burns, trauma, and chronic neuromuscular disorders. Caution is advised when administering a dose in any of these conditions and long stay ICU patients. Most practitioners in ICU would consider suxamethonium as a second line agent for RSI when there is a contraindication to rocuronium e.g. allergy or recent administration of sugammadex. Suxamethonium is the only NMBA available for IM injection.

The decision between using a bolus regime or the use of an infusion is at the discretion of the medical and nursing teams looking after the patient. Generally if the patient requires ongoing neuromuscular blockade an infusion is a pragmatic choice. The one exception is during transfer when an additional infusion pump is unnecessary and repeated boluses are the most practical solution.

**Dose**

The following table outlines the dosing options for the four main NMBAs. If administering an infusion, first administer the usual bolus dose, unless the patient has just received a bolus of NMBA, and then start the infusion immediately.

| | Rocuronium | Atracurium | Cisatracurium | Suxamethonium |
|---|---|---|---|---|
| **Concentration (mg/ml)** | 10 | 10 | 2 | 50 |
| **Dosing weight** | Ideal body weight | Ideal body weight | Ideal body weight | Total body weight |
| **Usual bolus dose (mg/kg)** | 0.6 | 0.5 (0.3 to 0.6) | 0.15 (0.1 to 0.4) | NA |
| **RSI bolus dose (mg/kg)** | 1.0 (0.9 to 1.2) | NA | NA | 1 (1 to 2) |
| **Continuous Infusion rate (mg/kg/hr)** | 0.6 (0.3 to 0.6) | 0.5 (0.3 to 1.7) | 0.5 (0.03 to 0.6) | NA |
| **IM dose (mg/kg)** | NA | NA | NA | 4 (4 to 5) |
| **Further dosing info** | Higher RSI doses result in quicker and improved intubating conditions. | Infusion rates >0.6 mg/kg/hr are high dose but often required after a prolonged period. The literature describes rates up to 1.7mg/kg/hr. | Can be used at a fixed dose of 37.5mg/hr, regardless of patient weight, based on trial data. | In practice most clinicians choose an IV dose of either 100mg (2ml) or 150mg (3ml) depending on patient size for RSI. |
| **Notes** | Reliant on hepatic and renal clearance and can accumulate with prolonged infusions. | No dosing adjustment required in hepatic or renal dysfunction. Associated with histamine release. | No dosing adjustment required in hepatic or renal dysfunction. Not associated with histamine release. | Not for continuous infusion. Caution in prolonged immobility, burns, trauma, and chronic neuromuscular disorders. |

## Monitoring

Peripheral nerve stimulation monitoring

Generally monitoring is not required for single bolus doses or RSI doses.

Alongside clinical assessment, for NMBA infusions (and in some occasions repeated bolus doses), a peripheral nerve stimulator may be used. The infusion rate (or bolus dose frequency) should be adjusted to maintain twitch response at 10% of control twitch height or to maintain 1 to 2 responses to train-of-four stimulation.

Depth of anaesthesia / sedation

Adequate depth of sedation should be maintained while NMBAs are being used to avoid unintended patient awareness and recall. BIS monitoring is available in the unit. However, we recommend frequent clinical assessment specifically looking for surrogate markers of inadequate sedation such as: tachycardia; hypertension; diaphoresis; and ventilator asynchrony.

## Reversal with Sugammadex

Sugammadex is a reversal agent that can be used to reverse the effects of rocuronium and vecuronium.

It is available as 200mg in 2ml or 500mg in 5ml.

Doses

- **Immediate reversal of RSI** intubating dose (0.9 to 1.2mg/kg) of rocuronium: **16mg/kg**
- **Deep block** (no response on train-of-four) : **4mg/kg**
- **Shallow block** (two responses on train-of-four): **2mg/kg**

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Noradrenaline: Central (CVC) administration overview

### Form

1mg/ml solution in 4ml ampoule. Total dose per ampoule is 4mg.

### Preparation

All preparations are made in 50ml syringes and infused using an infusion pump running at a rate in millilitres per hour (ml/hr). This is prepared as either “Single strength” (usual starting strength); “Double strength”; or “Quadruple strength” (“Quad strength”). The lowest strength that minimises syringe changes is chosen, generally a pragmatic way of doing this is to choose a strength that allows the infusion rate to be established at ≤ 15ml/hr.

### Peripheral strength

This is not covered in this guideline, and a separate guideline is used for peripheral noradrenaline. Note final concentration for peripheral noradrenaline is always 16 µg/ml; can also be described as 0.016mg/ml (this is one-fifth the concentration of single strength noradrenaline).

### Single strength (standard or starting concentration)

Dilute 4mg (4ml) with 46ml of 5% glucose. The final concentration is 80 micrograms per millilitre (80 µg/ml; can also be described as 0.08mg/ml).

### Double strength

Dilute 8mg (8ml) with 42ml of 5% glucose. The final concentration is 160 micrograms per millilitre (160 µg/ml; can also be described as 0.16mg/ml).

### Quadruple “Quad” strength

Dilute 16mg (16ml) with 34ml of 5% glucose. The final concentration is 320 micrograms per millilitre (320 µg/ml; can also be described as 0.32mg/ml).

### Higher concentrations

Concentrations above Quadruple strength (320 µg/ml) are generally discouraged but can be used in very exceptional circumstances after discussion with the nurse in charge and consultant in charge.

### Administration

Central line use only, except in very exceptional circumstances.

### Dose titration

This should be guided by the clinical team and dose in ml/hr titrated to achieve a target Mean Arterial Pressure (MAP). A starting dose of 5 to 10ml/hr is generally pragmatic, with rate increased or decreased by 0.5 to 5ml/hr depending on urgency of the clinical situation, degree of hypotension, and underlying condition causing shock. These starting doses and titration

are a very rough guide and apply to single strength (80 µg/ml) Noradrenaline only. Titration increments and starting doses should be altered accordingly for the higher concentration infusions. A step by step guide on titration is beyond the scope of this guideline, and those unfamiliar with titration of vasopressors should be closely supervised by an experienced ICU nurse and / or doctor.

**Dose range**

The most precise description of an infusion rate or dose is to describe this as micrograms per kg per minute (µg/kg/min) rather than in millilitres per hour (ml/hr). This allows better understanding when changing from one infusion concentration to another and taking into account the patient mass and size.

The usual dose is:

Zero to one micrograms per kg per minute (0 to 1.0 µg/kg/min) of ideal body weight (IBW)

Doses above 0.5µg/kg/min should be considered high dose infusions; doses >1µg/kg/min are very high dose and these patients should be reviewed by the senior clinician. Doses above 1.5µg/kg/min can be used but are extremely high dose infusions, and these patients will need consultant review.

**Calculating dose in micrograms per kg per minute (µg/kg/min)**

The formula is:

$$Dose\ (\mu g/kg/\min) = \frac{Infusion\ rate \times infusion\ concentration}{Weight \times 60}$$

Where:

- Infusion rate is in millilitres per hour (ml/hr)
- Infusion concentration is the concentration in micrograms per millilitre (µg/ml). The concentrations are as follows:
  - Single strength = 80 µg/ml
  - Double strength = 160 µg/ml
  - Quad strength = 320 µg/ml
  - Other: Peripheral strength = 16 µg/ml (go to peripheral noradrenaline)
- Weight is ideal body weight in kilograms (kg)
- "60" corresponds to 60 minutes to convert µg/kg/hr to µg/kg/min

**There are infusion tables for each concentration at the following links for single, double, and quadruple or by looking under the respective sub-menus.**

# Noradrenaline: Single strength

### Single strength (standard or starting concentration)

Dilute 4mg (4ml) of Noradrenaline with 46ml of 5% glucose. The final concentration is 80 micrograms per millilitre (80 µg/ml; can also be described as 0.08mg/ml).

### Administration

Central line use only, except in very exceptional circumstances.

### Dose titration

Doses (in ml/hr) are titrated to achieve a target Mean Arterial Pressure (MAP). A starting dose of 5 to 10ml/hr is generally pragmatic, with rate increased or decreased by 0.5 to 5ml/hr depending on urgency of the clinical situation, degree of hypotension or shock, and underlying condition causing shock. If unsure check with a senior nurse or doctor.

### Dose range

Best practice is to calculate the dose in micrograms per kg per minute (µg/kg/min) of ideal body weight (IBW). The usual dose is:

Zero to one micrograms per kg per minute (0 to 1.0 µg/kg/min) of IBW

Doses above 0.5µg/kg/min should be considered high dose infusions; doses >1µg/kg/min are very high dose and these patients should be reviewed by the senior clinician. Doses above 1.5µg/kg/min can be used but are extremely high dose infusions, and these patients will need consultant review.

### Calculating dose in micrograms per kg per minute (µg/kg/min) for single strength (80 µg/ml)

Formula:

$$Dose\ (\mu g/kg/\min) = \frac{Infusion\ rate \times 80}{Weight \times 60}$$

Where:

- Infusion rate is in millilitres per hour (ml/hr)
- “80” corresponds to the infusion concentration, for single strength this is 80µg/ml
- Weight is ideal body weight in kg
- “60” corresponds to 60 minutes to convert µg/kg/hr to µg/kg/min

# Noradrenaline: Single strength dosing table

**The following table contains the infusion rates in ml/hr for a given patient weight (kg) and specific doses (µg/kg/min)**

| Noradrenaline: Single strength (4mg per 50ml) Dose (µg/kg/min) | Ideal Body Weight (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| | Infusion rate (ml/hr) | | | | | | | | | | | | | |
| 0.05 | 1.3 | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 |
| 0.1 | 2.6 | 3.0 | 3.4 | 3.8 | 4.1 | 4.5 | 4.9 | 5.3 | 5.6 | 6.0 | 6.4 | 6.8 | 7.1 | 7.5 |
| 0.15 | 3.9 | 4.5 | 5.1 | 5.6 | 6.2 | 6.8 | 7.3 | 7.9 | 8.4 | 9.0 | 9.6 | 10.1 | 10.7 | 11.3 |
| 0.2 | 5.3 | 6.0 | 6.8 | 7.5 | 8.3 | 9.0 | 9.8 | 10.5 | 11.3 | 12.0 | 12.8 | 13.5 | 14.3 | 15.0 |
| 0.25 | 6.6 | 7.5 | 8.4 | 9.4 | 10.3 | 11.3 | 12.2 | 13.1 | 14.1 | 15.0 | 15.9 | 16.9 | 17.8 | 18.8 |
| 0.3 | 7.9 | 9.0 | 10.1 | 11.3 | 12.4 | 13.5 | 14.6 | 15.8 | 16.9 | 18.0 | 19.1 | 20.3 | 21.4 | 22.5 |
| 0.35 | 9.2 | 10.5 | 11.8 | 13.1 | 14.4 | 15.8 | 17.1 | 18.4 | 19.7 | 21.0 | 22.3 | 23.6 | 24.9 | 26.3 |
| 0.4 | 10.5 | 12.0 | 13.5 | 15.0 | 16.5 | 18.0 | 19.5 | 21.0 | 22.5 | 24.0 | 25.5 | 27.0 | 28.5 | 30.0 |
| 0.45 | 11.8 | 13.5 | 15.2 | 16.9 | 18.6 | 20.3 | 21.9 | 23.6 | 25.3 | 27.0 | 28.7 | 30.4 | 32.1 | 33.8 |
| 0.5 | 13.1 | 15.0 | 16.9 | 18.8 | 20.6 | 22.5 | 24.4 | 26.3 | 28.1 | 30.0 | 31.9 | 33.8 | 35.6 | 37.5 |
| 0.6 | 15.8 | 18.0 | 20.3 | 22.5 | 24.8 | 27.0 | 29.3 | 31.5 | 33.8 | 36.0 | 38.3 | 40.5 | 42.8 | 45.0 |
| 0.7 | 18.4 | 21.0 | 23.6 | 26.3 | 28.9 | 31.5 | 34.1 | 36.8 | 39.4 | 42.0 | 44.6 | 47.3 | 49.9 | 52.5 |
| 0.8 | 21.0 | 24.0 | 27.0 | 30.0 | 33.0 | 36.0 | 39.0 | 42.0 | 45.0 | 48.0 | 51.0 | 54.0 | 57.0 | 60.0 |
| 0.9 | 23.6 | 27.0 | 30.4 | 33.8 | 37.1 | 40.5 | 43.9 | 47.3 | 50.6 | 54.0 | 57.4 | 60.8 | 64.1 | 67.5 |
| 1 | 26.3 | 30.0 | 33.8 | 37.5 | 41.3 | 45.0 | 48.8 | 52.5 | 56.3 | 60.0 | 63.8 | 67.5 | 71.3 | 75.0 |
| 1.1* | 28.9 | 33.0 | 37.1 | 41.3 | 45.4 | 49.5 | 53.6 | 57.8 | 61.9 | 66.0 | 70.1 | 74.3 | 78.4 | 82.5 |
| 1.2* | 31.5 | 36.0 | 40.5 | 45.0 | 49.5 | 54.0 | 58.5 | 63.0 | 67.5 | 72.0 | 76.5 | 81.0 | 85.5 | 90.0 |
| 1.3* | 34.1 | 39.0 | 43.9 | 48.8 | 53.6 | 58.5 | 63.4 | 68.3 | 73.1 | 78.0 | 82.9 | 87.8 | 92.6 | 97.5 |
| 1.4* | 36.8 | 42.0 | 47.3 | 52.5 | 57.8 | 63.0 | 68.3 | 73.5 | 78.8 | 84.0 | 89.3 | 94.5 | 99.8 | 105.0 |
| 1.5* | 39.4 | 45.0 | 50.6 | 56.3 | 61.9 | 67.5 | 73.1 | 78.8 | 84.4 | 90.0 | 95.6 | 101.3 | 106.9 | 112.5 |

**Star (*) = extremely high dose**

| Section authors: Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane | Date authorised: April 2023 | Review date: April 2026 |
|---|---|---|

# Noradrenaline: Double strength

### Double strength

Dilute 8mg (8ml) of Noradrenaline with 42ml of 5% glucose. The final concentration is 160 micrograms per millilitre (160µg/ml; can also be described as 0.16mg/ml).

### Administration

Central line use only.

### Dose titration

Doses (in ml/hr) are titrated to achieve a target Mean Arterial Pressure (MAP). Generally the patient is already receiving another concentration of noradrenaline (either single or quad strength) and this should be converted to the correct double strength dose in ml/hr. If not already receiving any noradrenaline a starting dose of 3 to 10ml/hr is generally pragmatic. Rate should be increased or decreased by 0.5 to 5ml/hr depending on urgency of the clinical situation, degree of hypotension or shock, and underlying condition causing shock. If unsure check with a senior nurse or doctor.

### Dose range

Best practice is to calculate the dose in micrograms per kg per minute (µg/kg/min) of ideal body weight (IBW). The usual dose is:

Zero to one micrograms per kg per minute (0 to 1.0 µg/kg/min) of IBW

Doses above 0.5µg/kg/min should be considered high dose infusions; doses >1µg/kg/min are very high dose and these patients should be reviewed by the senior clinician. Doses above 1.5µg/kg/min can be used but are extremely high dose infusions, and these patients will need consultant review.

### Calculating dose in micrograms per kg per minute (µg/kg/min) for double strength (160 µg/ml)

Formula:

$$Dose\ (\mu g/kg/\min) = \frac{Infusion\ rate \times 160}{Weight \times 60}$$

Where:

- Infusion rate is in millilitres per hour (ml/hr)
- “160” corresponds to the infusion concentration, for double strength this is 160µg/ml
- Weight is in kg
- “60” corresponds to 60 minutes to convert µg/kg/hr to µg/kg/min

# Noradrenaline: Double strength dosing table

**The following table contains the infusion rates in ml/hr for a given patient weight (kg) and specific doses (µg/kg/min)**

| Noradrenaline: Double strength (8mg per 50ml) Dose (µg/kg/min) | Ideal Body Weight (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| | Infusion rate (ml/hr) | | | | | | | | | | | | | |
| 0.05 | 0.7 | 0.8 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 |
| 0.1 | 1.3 | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 |
| 0.15 | 2.0 | 2.3 | 2.5 | 2.8 | 3.1 | 3.4 | 3.7 | 3.9 | 4.2 | 4.5 | 4.8 | 5.1 | 5.3 | 5.6 |
| 0.2 | 2.6 | 3.0 | 3.4 | 3.8 | 4.1 | 4.5 | 4.9 | 5.3 | 5.6 | 6.0 | 6.4 | 6.8 | 7.1 | 7.5 |
| 0.25 | 3.3 | 3.8 | 4.2 | 4.7 | 5.2 | 5.6 | 6.1 | 6.6 | 7.0 | 7.5 | 8.0 | 8.4 | 8.9 | 9.4 |
| 0.3 | 3.9 | 4.5 | 5.1 | 5.6 | 6.2 | 6.8 | 7.3 | 7.9 | 8.4 | 9.0 | 9.6 | 10.1 | 10.7 | 11.3 |
| 0.35 | 4.6 | 5.3 | 5.9 | 6.6 | 7.2 | 7.9 | 8.5 | 9.2 | 9.8 | 10.5 | 11.2 | 11.8 | 12.5 | 13.1 |
| 0.4 | 5.3 | 6.0 | 6.8 | 7.5 | 8.3 | 9.0 | 9.8 | 10.5 | 11.3 | 12.0 | 12.8 | 13.5 | 14.3 | 15.0 |
| 0.45 | 5.9 | 6.8 | 7.6 | 8.4 | 9.3 | 10.1 | 11.0 | 11.8 | 12.7 | 13.5 | 14.3 | 15.2 | 16.0 | 16.9 |
| 0.5 | 6.6 | 7.5 | 8.4 | 9.4 | 10.3 | 11.3 | 12.2 | 13.1 | 14.1 | 15.0 | 15.9 | 16.9 | 17.8 | 18.8 |
| 0.6 | 7.9 | 9.0 | 10.1 | 11.3 | 12.4 | 13.5 | 14.6 | 15.8 | 16.9 | 18.0 | 19.1 | 20.3 | 21.4 | 22.5 |
| 0.7 | 9.2 | 10.5 | 11.8 | 13.1 | 14.4 | 15.8 | 17.1 | 18.4 | 19.7 | 21.0 | 22.3 | 23.6 | 24.9 | 26.3 |
| 0.8 | 10.5 | 12.0 | 13.5 | 15.0 | 16.5 | 18.0 | 19.5 | 21.0 | 22.5 | 24.0 | 25.5 | 27.0 | 28.5 | 30.0 |
| 0.9 | 11.8 | 13.5 | 15.2 | 16.9 | 18.6 | 20.3 | 21.9 | 23.6 | 25.3 | 27.0 | 28.7 | 30.4 | 32.1 | 33.8 |
| 1 | 13.1 | 15.0 | 16.9 | 18.8 | 20.6 | 22.5 | 24.4 | 26.3 | 28.1 | 30.0 | 31.9 | 33.8 | 35.6 | 37.5 |
| 1.1* | 14.4 | 16.5 | 18.6 | 20.6 | 22.7 | 24.8 | 26.8 | 28.9 | 30.9 | 33.0 | 35.1 | 37.1 | 39.2 | 41.3 |
| 1.2* | 15.8 | 18.0 | 20.3 | 22.5 | 24.8 | 27.0 | 29.3 | 31.5 | 33.8 | 36.0 | 38.3 | 40.5 | 42.8 | 45.0 |
| 1.3* | 17.1 | 19.5 | 21.9 | 24.4 | 26.8 | 29.3 | 31.7 | 34.1 | 36.6 | 39.0 | 41.4 | 43.9 | 46.3 | 48.8 |
| 1.4* | 18.4 | 21.0 | 23.6 | 26.3 | 28.9 | 31.5 | 34.1 | 36.8 | 39.4 | 42.0 | 44.6 | 47.3 | 49.9 | 52.5 |
| 1.5* | 19.7 | 22.5 | 25.3 | 28.1 | 30.9 | 33.8 | 36.6 | 39.4 | 42.2 | 45.0 | 47.8 | 50.6 | 53.4 | 56.3 |

**Star (*) = extremely high dose**

| Section authors: Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane | Date authorised: April 2023 | Review date: April 2026 |
|---|---|---|

# Noradrenaline: Quadruple ("Quad") strength

### Quadruple "Quad" strength

Dilute 16mg (16ml) of Noradrenaline with 34ml of 5% glucose. The final concentration is 320 micrograms per millilitre (320µg/ml; can also be described as 0.32mg/ml).

### Administration

Central line use only.

### Dose titration

Doses (in ml/hr) are titrated to achieve a target Mean Arterial Pressure (MAP). Generally the patient is already receiving another concentration of noradrenaline (either single or double strength) and this should be converted to the correct Quad strength dose in ml/hr. It would be very unusual to start Quad strength if not already receiving any noradrenaline. Generally starting doses will be much lower and an exact starting dose cannot be recommended. Rate should be increased or decreased by 0.2 to 2.5ml/hr depending on urgency of the clinical situation, degree of hypotension or shock, and underlying condition causing shock. If unsure check with a senior nurse or doctor.

### Dose range

Best practice is to calculate the dose in micrograms per kg per minute (µg/kg/min) of ideal body weight (IBW). The usual dose is:

Zero to one micrograms per kg per minute (0 to 1.0 µg/kg/min) of IBW

Doses above 0.5µg/kg/min should be considered high dose infusions; doses > 1µg/kg/min are very high dose and these patients should be reviewed by the senior clinician. Doses above 1.5µg/kg/min can be used but are extremely high dose infusions, and these patients will need consultant review.

### Calculating dose in micrograms per kg per minute (µg/kg/min) for Quadruple strength (320 µg/ml)

Formula:

$$Dose\ (\mu g/kg/\min) = \frac{Infusion\ rate \times 320}{Weight \times 60}$$

Where:

- Infusion rate is in millilitres per hour (ml/hr)
- "320" corresponds to the infusion concentration, for single strength this is 320µg/ml
- Weight is in kg
- "60" corresponds to 60 minutes to convert µg/kg/hr to µg/kg/min

# Noradrenaline: Quadruple strength dosing table

**The following table contains the infusion rates in ml/hr for a given patient weight (kg) and specific doses (µg/kg/min)**

| Noradrenaline: Quad strength (16mg per 50ml) | Dose (µg/kg/min) | Ideal Body Weight (kg) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| | | Infusion rate (ml/hr) | | | | | | | | | | | | | |
| | 0.05 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 | 0.8 | 0.8 | 0.9 | 0.9 |
| | 0.1 | 0.7 | 0.8 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 |
| | 0.15 | 1.0 | 1.1 | 1.3 | 1.4 | 1.5 | 1.7 | 1.8 | 2.0 | 2.1 | 2.3 | 2.4 | 2.5 | 2.7 | 2.8 |
| | 0.2 | 1.3 | 1.5 | 1.7 | 1.9 | 2.1 | 2.3 | 2.4 | 2.6 | 2.8 | 3.0 | 3.2 | 3.4 | 3.6 | 3.8 |
| | 0.25 | 1.6 | 1.9 | 2.1 | 2.3 | 2.6 | 2.8 | 3.0 | 3.3 | 3.5 | 3.8 | 4.0 | 4.2 | 4.5 | 4.7 |
| | 0.3 | 2.0 | 2.3 | 2.5 | 2.8 | 3.1 | 3.4 | 3.7 | 3.9 | 4.2 | 4.5 | 4.8 | 5.1 | 5.3 | 5.6 |
| | 0.35 | 2.3 | 2.6 | 3.0 | 3.3 | 3.6 | 3.9 | 4.3 | 4.6 | 4.9 | 5.3 | 5.6 | 5.9 | 6.2 | 6.6 |
| | 0.4 | 2.6 | 3.0 | 3.4 | 3.8 | 4.1 | 4.5 | 4.9 | 5.3 | 5.6 | 6.0 | 6.4 | 6.8 | 7.1 | 7.5 |
| | 0.45 | 3.0 | 3.4 | 3.8 | 4.2 | 4.6 | 5.1 | 5.5 | 5.9 | 6.3 | 6.8 | 7.2 | 7.6 | 8.0 | 8.4 |
| | 0.5 | 3.3 | 3.8 | 4.2 | 4.7 | 5.2 | 5.6 | 6.1 | 6.6 | 7.0 | 7.5 | 8.0 | 8.4 | 8.9 | 9.4 |
| | 0.6 | 3.9 | 4.5 | 5.1 | 5.6 | 6.2 | 6.8 | 7.3 | 7.9 | 8.4 | 9.0 | 9.6 | 10.1 | 10.7 | 11.3 |
| | 0.7 | 4.6 | 5.3 | 5.9 | 6.6 | 7.2 | 7.9 | 8.5 | 9.2 | 9.8 | 10.5 | 11.2 | 11.8 | 12.5 | 13.1 |
| | 0.8 | 5.3 | 6.0 | 6.8 | 7.5 | 8.3 | 9.0 | 9.8 | 10.5 | 11.3 | 12.0 | 12.8 | 13.5 | 14.3 | 15.0 |
| | 0.9 | 5.9 | 6.8 | 7.6 | 8.4 | 9.3 | 10.1 | 11.0 | 11.8 | 12.7 | 13.5 | 14.3 | 15.2 | 16.0 | 16.9 |
| | 1 | 6.6 | 7.5 | 8.4 | 9.4 | 10.3 | 11.3 | 12.2 | 13.1 | 14.1 | 15.0 | 15.9 | 16.9 | 17.8 | 18.8 |
| | 1.1* | 7.2 | 8.3 | 9.3 | 10.3 | 11.3 | 12.4 | 13.4 | 14.4 | 15.5 | 16.5 | 17.5 | 18.6 | 19.6 | 20.6 |
| | 1.2* | 7.9 | 9.0 | 10.1 | 11.3 | 12.4 | 13.5 | 14.6 | 15.8 | 16.9 | 18.0 | 19.1 | 20.3 | 21.4 | 22.5 |
| | 1.3* | 8.5 | 9.8 | 11.0 | 12.2 | 13.4 | 14.6 | 15.8 | 17.1 | 18.3 | 19.5 | 20.7 | 21.9 | 23.2 | 24.4 |
| | 1.4* | 9.2 | 10.5 | 11.8 | 13.1 | 14.4 | 15.8 | 17.1 | 18.4 | 19.7 | 21.0 | 22.3 | 23.6 | 24.9 | 26.3 |
| | 1.5* | 9.8 | 11.3 | 12.7 | 14.1 | 15.5 | 16.9 | 18.3 | 19.7 | 21.1 | 22.5 | 23.9 | 25.3 | 26.7 | 28.1 |

**Star (*) = extremely high dose**

| Section authors: Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane | Date authorised: April 2023 | Review date: April 2026 |
|---|---|---|

# Noradrenaline: Peripheral

There is a full guideline on the use of peripheral noradrenaline and this can be found on the GG&C guideline platform once available here.

The key points of note are:

### Concentration

The standard peripheral concentration is 16µg/ml (16 micrograms per millilitre; or 0.016mg/ml)

The infusions are made in either 5% glucose or 0.9% sodium chloride, the two options are:

- 250ml bag: Remove 4ml from a 250ml bag and add 4mg of Noradrenaline

**OR**

- 500ml bag: Remove 8ml from a 500ml bag and add 8mg of Noradrenaline

### Maximum infusion rate

There is a maximum rate for peripheral noradrenaline which is:

0.2µg/kg/min (0.2 micrograms per kilogram per minute)

### Risks

The primary risk is extravasation and tissue necrosis. Peripheral noradrenaline infusions should not continue for prolonged periods (generally < 24 hours). Cannulas need to be checked hourly. Please see the full guideline (here) before using peripheral noradrenaline.

# Phosphate

### ICU Indication

Correction or prevention of hypophosphataemia

### Adult Dose

20mmol phosphate

### Form

Three preparations are available:

- **Sodium acid phosphate** 31.2% 10ml ampoules (contains 20mmol phosphate and 20mmol sodium in 10ml);
- **Sodium Glycerophosphate (Glycophos)** 20ml ampoules (contains 20mmol phosphate and 40mmol sodium in 20ml);
- **Potassium Phosphate** 13.6% ampoules (contains 10mmol phosphate and 10mmol potassium in 10ml)

### Administration

### Peripheral Administration

Give 20ml Glycophos in 500ml of 5% glucose over 12 hours. If patient is fluid restricted then 20ml Glycophos can be given in 100ml of 5% glucose over 12 hours.

### Central Administration

Two options:

- Dilute 10ml sodium acid phosphate 31.2% to 60ml with 5% glucose or 0.9% sodium chloride and infuse over 3 hours
- Dilute 20ml potassium phosphate 13.6% to 60ml with 5% glucose or 0.9% sodium chloride and infuse over 3 hours

### Monitoring

- Continuous ECG monitoring
- Electrolytes: serum phosphate, potassium, and sodium

### Cautions

- Renal function: lower doses may be required in patients with renal impairment
- Hypernatraemia

### Adverse Effects

- Hypotension
- Hyperphosphataemia
- Hypocalcaemia
- Hypernatraemia
- Hyperkalaemia

### Other

Phosphate is incompatible with calcium and will precipitate.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Potassium

### ICU Indication

Correction or prevention of hypokalaemia

### Adult Dose

20 to 60mmol depending on serum potassium and intravenous access

### Form

1. Potassium Chloride 15%; 20mmol/10ml ampoules
2. Ready-made 500ml infusion bags:
    - 5% glucose with 20mmol potassium chloride
    - 0.9% sodium chloride with 20mmol potassium chloride
    - 5% glucose with 40mmol potassium chloride
    - 0.9% sodium chloride with 40mmol potassium chloride

### Administration
### Peripheral Administration

Give ready-made 500ml infusion bag with 20mmol or 40mmol potassium chloride at a rate of 10mmol per hour (maximum rate of 20mmol per hour may be given with ECG monitoring).

Solutions containing more than 20mmol of potassium in 500ml can cause pain and phlebitis when administered peripherally.

### Central Administration

Depending on requirements there are three options:

- Dilute 20mmol (10ml) potassium chloride to 20ml with 0.9% sodium chloride or 5% glucose and infuse over 1 hour
- Dilute 40mmol (20ml) potassium chloride to 40ml with 0.9% sodium chloride or 5% glucose and infuse over 2 hours
- Dilute 60mmol (30ml) potassium chloride to 60ml with 0.9% sodium chloride or 5% glucose and infuse over 3 hours

### Monitoring

- Continuous ECG monitoring
- Serum potassium and magnesium
- Monitor injection site for signs of phlebitis

### Cautions

- Impaired renal function with oliguria/anuria
- Concomitant use of potassium sparing diuretics

### Adverse Effects

- Hyperkalaemia
- Pain / phlebitis at injection site
- Arrhythmias

### Other

If potassium chloride is added to an infusion fluid or diluted in a syringe, thorough mixing is essential to avoid 'layering' which can result in a bolus dose being delivered to the patient.

In severe hypokalaemia it is preferable to give potassium in sodium chloride rather than glucose as glucose may cause a further fall in serum potassium.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Propofol bolus

For use in patients ≥16 years.

### ICU Indication

To achieve a rapid increase in the depth of sedation in haemodynamically stable patients maintained on a continuous infusion of propfol.

### Adult Dose

10 to 20mg IV bolus

Base initial dose on patient's age, weight, haemodynamic status and current infusion dose.

A further bolus dose can be given after 2 minutes if required. Discuss any further bolus doses with medical staff.

### Form

Propofol 20mg/ml (2%) emulsion for injection.

### Monitoring

Monitor patient for hypotension, bradycardia, arrhythmia, apnoea.

### Documentation

Document all bolus doses on Carevue. Please record any adverse response to bolus doses.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Propofol infusion

### Indication

Standard sedation for intubated and ventilated patients.

### Dose

Propofol is administered as a continuous infusion. This should be guided by the clinical team and dosed in mg/kg/hr to achieve the desired level of sedation, up to a **maximum** of 4mg/kg/hr adjusted body weight (click here for a bodyweight calculator).

### Form

Available as 2% (1000mg/50ml) emulsion for infusion. Also available as 1% (500mg/50ml) emulsion for infusion: at the RAH the 2% strength is used first line.

### Administration

Propofol can be administered by intravenous infusion either centrally or peripherally. This should be used neat and does not need further dilution.

### Monitoring

Monitor patient for hypotension, bradycardia / tachycardia, delirium, agitation, and apnoea

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

## Salbutamol infusion (peripheral strength)

**There are two strengths of salbutamol infusion used within the RAH, please ensure the correct dosing table is selected. Please always utilise the drug library on the critical care smart Infusion Pumps to safeguard against errors.**

Please see the green box on the next page for CVC / concentrated infusion

Follow NHS GGC guidance when prescribing and administering intravenous salbutamol. This can be accessed via the NHS GGC Adults Therapeutic Handbook here

**Form**

Available as 5mg/5ml infusion solution

**Preparation**

Dilute 5ml (5mg) of solution with 500ml of 5% glucose or 0.9% sodium chloride. The final concentration is 10 micrograms per millilitre (10 µg/ml; can also be described as 0.01mg/ml)

**Administration**

Preferably infused centrally, if no central access administer via large peripheral vein

**Dose**

Initially 5 micrograms/minute adjusted to response and heart rate. Usual dose range is 3 to 20 micrograms/minute

| **Peripheral Salbutamol**<br>**Standard strength infusion (10 µg/ml; 5mg/500ml)** | |
|---|---|
| **Dose (micrograms/minute)** | **Infusion Rate (ml/hour)** |
| 3 | 18 |
| 5 | 30 |
| 8 | 48 |
| 10 | 60 |
| 15 | 90 |
| 20 | 120 |

## Salbutamol infusion (CVC strength)

Patients on prolonged salbutamol infusions can become fluid overloaded because of the volume administered. In these patients a concentrated infusion can be administered **via central line only.** This is often the preferred route in intensive care with peripheral infusions often preferred in HDU.

### Preparation

Dilute 10mg (10ml) of Salbutamol 5mg/5ml solution with 40ml of 5% glucose or 0.9% sodium chloride. The final concentration is 200 micrograms per millilitre (200 µg/ml; can also be described as 0.2mg/ml)

### Administration

Via central line only

### Dose

As above, initially 5 micrograms/minute adjusted to response and heart rate. Usual dose range is 3 to 20 micrograms/minute

| **CVC (concentrated) infusion**<br>**CVC strength infusion: 200 µg/ml; 10mg/50ml** | |
|---|---|
| **Dose (micrograms/minute)** | **Infusion Rate (ml/hour)** |
| 3 | 0.9 |
| 5 | 1.5 |
| 8 | 2.4 |
| 10 | 3 |
| 15 | 4.5 |
| 20 | 6 |

| | |
|---|---|
| Section authors | Philip Henderson; Fiona MacGregor |
| Date authorised | February 2025 |
| Section review date | April 2026 |

# Vancomycin

Follow NHS GGC guidance when prescribing and administering vancomycin. Note that within RAH ICU the preferred means of administering vancomycin is via continuous infusion. Guidance for prescribing and monitoring continuous vancomycin can be found here.

The vancomycin calculator can be accessed here (backup indirect link can be accessed here).

## Patients receiving CVVHDF

### Loading dose

All patients should receive a weight-related loading dose

| Actual body weight | Dose | Volume of 0.9% sodium chloride or 5% glucose | Duration of infusion |
|---|---|---|---|
| <35 | 25mg/kg | 250ml | 60mins per 500mg |
| 35 – 44kg | 1000mg | 250ml | 2 hours |
| 45 – 59kg | 1500mg | 500ml (peripheral)<br>250ml (central ) | 3 hours |
| 60-89kg | 2000mg | 500ml (peripheral)<br>250ml (central) | 4 hours |
| 90-119kg | 2500mg | 500ml (peripheral)<br><br>250ml(central) | 5 hours |
| ≥120kg | 3000mg | 1000ml (peripheral)<br><br>500ml (central) | 6 hours |

### Maintenance infusion

Daily dose should be initiated at 500mg per 24 hours, administered as 2 x 12 hour infusions of 250mg.

Start the maintenance intravenous infusion immediately after the loading dose.

Adjust the dose as per the next page or click here

## Dose adjustment

Request a serum level 12 hours after starting the infusion then with the routine bloods each morning, or as advised by the pharmacist. Dosage adjustments should be made using the following guidelines.

| Vancomycin concentration | Suggested dosage change |
|---|---|
| < 15 mg/l | Increase 12 hourly dose by 250mg |
| **15 – 25 mg/l** | **No change if patient responding to treatment**<br><br>**Consider aiming for a steady state level of 20-25mg/l if the patient remains seriously ill** |
| 26 - 30 mg/l | Decrease 12 hourly dose by 250mg* |
| > 30 mg/l | Stop until <25mg/l then restart at a lower dose |

***If the patient is only receiving 500mg/day, reduce 12 hourly dose to 125mg**

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# Vasopressin

### ICU Indications

Refractory vasodilatory shock, resistant to catecholamine vasopressors and adequate intravascular volume or when high dose catecholamines are considered undesirable (unlicensed).

### Adult Dose

Local policy is to infuse at 2.4units per hour (0.04units/min).

### Form

Argipressin (synthetic vasopressin) 20units in 1ml solution for injection.

### Preparation

Dilute 20units (1ml) vasopressin with 49ml of 0.9% sodium chloride or 5% glucose. The final concentration is 0.4 units per millilitre (0.4unit/ml).

### Administration

Run infusion at 6 ml/hr. Administer via a central line.

### Monitoring

Allergic-type reactions, Extravasation, Close cardiovascular monitoring, Signs of peripheral vasoconstriction, Urine output

### Cautions

Known sensitivity to vasopressin, Vascular diseases especially of the coronary arteries, Coronary insufficiency, Arrthythmias

### Adverse Effects

Paradoxical Diuresis (low dose), Platelet aggregation (high dose), Myocardial ischaemia (doses > 0.04units/min), Reduced cardiac output (high dose), Asystole/ arrhythmias, Chest pain, Peripheral ischaemia, Abdominal cramping, Tremor, Mesenteric ischaemia, Bronchoconstriction, Increased cortisol levels

### Other

Physically and chemically stable for 12 hours at room temperature.

| | |
|---|---|
| Section authors | Philip Henderson; Radha Sundaram; Fiona MacGregor; Stewart McFarlane |
| Date authorised | April 2023 |
| Section review date | April 2026 |

# References and related guidelines

| References / Evidence | |
|---|---|
| **References** | https://www.medicines.org.uk/emc<br><br>https://bnf.nice.org.uk/ |
| **Evidence Method** | This guideline has used available evidence, the product / manufacturers literature, alongside an evaluation of standard practice within the RAH ICU.<br><br>This guideline has been through multiple rounds of review involving the medical, nursing, and pharmacy staff involved in Intensive Care delivery at RAH and suggestions and edits have been incorporated following this review. The Clyde Safer Use of Medicines committee have also approved this guideline (May 2023).<br><br>Where a Greater Glasgow and Clyde (GG&C), or hospital wide pharmacy or drug guideline exists this will not be repeated here and the original should be consulted in preference. |
| **Related Resources** | 1. GG&C Adult Therapeutics Handbook<br>2. Electronic medicines compendium (emc)<br>3. British National Formulary (BNF)<br>4. AAGBI Guidelines<br>5. AAGBI: Quick Reference Handbook (QRH)<br>6. Intensive Care Society Guidelines<br>7. Adult advanced life support Guidelines<br>8. Adult Advanced Life Support Algorithm (2021)<br>9. Resus UK 2021 Quick Reference Handbook (QRH)<br>10. Bodyweight calculators: Ideal and adjusted (MDCalc)<br>11. The obese patient, anaesthesia, and drug dosing (SOBA-UK)<br>12. Drug dosing in obese adults - PMC (nih.gov)<br>13. Drug dosing in the critically ill obese patient |
| **Related Guidelines** | https://ggcmedicines.org.uk/ |