

Handbook of Drug Administration (Critical Care)

Version 4.1

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Please note

Some drugs in this book are used outside the specification in the product licence. This is denoted throughout the text by the following abbreviations:

- I Unlicensed indication.
- D Limitations on dose or unlicensed dose - following advice of local experts, doses other than those specified in the data sheet are recommended.
- R Unlicensed dilution - dilution specified is not covered by product licence but is current practice at Whiston Hospital.

The clinician is advised that they take full responsibility for prescribing drugs outside the product licence. If further information is required they should refer to senior colleagues, the pharmacist, Medusa injectable medicines guide or the Data Sheet Compendium. Clinicians should also be aware that product licences may change throughout the life of this book.

This handbook is intended as an aid to nursing staff dealing with the preparation and administration of the drugs in a critical care environment. It does not include information around side effects, contraindications, etc.

For further information on the drugs included in this handbook please refer to either the Medusa website (www.medusa.wales.nhs.uk, username sthkstaff, password tiger1) or the individual SPC (Summary of Products Characteristics) for each drug available at www.medicines.org.uk. Alternatively contact the critical care pharmacist or, out of hours, the on call pharmacist (available via switchboard).

Any comments or queries about this guide please contact Greg Barton, critical care pharmacist on greg.barton@sthk.nhs.uk or 07766800197

Calculation of Ideal Body Weight (IBW)

For men 50 kg + (2.3 x number of inches in height over 5 ft)

For women 45.5 kg + (2.3 x number of inches in height over 5 ft)

Calculation of renal function

Creatinine clearance (mL/min) =
$$\frac{\text{Constant} \times (140 - \text{age in years}) \times \text{Weight (IBW) Kg}}{\text{Serum Creatinine mcmol/L}}$$

Constant	=	Men	1.23
		Women	1.04

QUICK GUIDE TO DILUTIONS/STANDARD RATES

<u>Drug</u>	<u>Strength</u>	<u>Diluent</u>	<u>Initial Rate</u>
Sedatives			
Propofol	1% (10mg/mL)	undiluted	up to 20mL/hr
Midazolam	50mg/50mL	undiluted	up to 5mL/hr
Clonidine	750microg/50mL	G or N	start at 2microgram/kg/hr
Dexmedetomidine	8mg/100mL	G or N	start at 0.7microgram/kg/hr
Analgesics			
Alfentanil (CD)	25mg/50mL	G or N	up to 10mL/hr
Morphine (CD)			
Continuous Infusion	60mg/60mL	G or N	up to 10mL/hr
PCA	100mg/mL	prefilled syringe (N)	1mg bolus, 5min lock out
Remifentanil (CD)	5mg/50mL	G or N	start at 0.1micrograms/kg/min for all indications (ideal body wt)
Inotropes/vasopressors			
Noradrenaline	8mg/50mL (or 16mg/50mL)	G	up to 20mL/hr of any strength (higher in exceptional circumstances)
synthetic Vasopressin (Argipressin/Pitressin®)	20 units/50mL	G or N	start at 4.5mL/hr
Adrenaline	4mg/50mL (or 8mg or 16mg/50mL)	G	up to 20mL/hr
Dobutamine	250mg/50mL	G or N	2.5-10micrograms/kg/min
Others			
Actrapid/Humulin S	50 units/50mL	N	as per BMs/Critical Care protocol
Atracurium	500mg/50mL	undiluted	0.65-0.78mg/kg/hr but titrate to response
Rocuronium	250mg/50mL	G or N	see monograph

Key: N = 0.9% sodium chloride, G = 5% glucose, WFI = Water for Injection, CD = Controlled drug
Refer to the relevant page in this booklet or Medusa for more detail

Common Drugs

ADRENALINE

PRESENTATION

1 ampoule (1 in 1,000) contains 1mg ADRENALINE in 1mL

INDICATIONS

Low cardiac output states (invasive monitoring e.g. arterial line required)
(For use as a peripheral vasopressor see page)

RECONSTITUTION (For IV infusion via a CENTRAL LINE)

Dilute 4mg (4 ampoules of 1 in 1,000) to 50mL with diluent (80micrograms/mL)

DILUENTS

5% glucose intravenous infusion only

DOSE

Low cardiac output states

Start at 1-5mL/hr of 4mg/50mL and titrate to the patient's pre-determined targets based on condition being treated using the parameters listed below. For high infusion rates use a more concentrated solution (see **NOTES**). **Usual range up to 20mL/hr** of any of the suggested concentrations.

- Adjust dose as rapidly as necessary according to CO, HR, MAP and/or urine output
- Ensure adequate intravascular volume replacement has/is occurring before using in low cardiac output states

Do not give without haemodynamic monitoring (e.g. blood pressure monitoring).

At the stated concentrations this **MUST** be given via a central line

Consider monitoring with a PICCO

NOTES

- 4mg/50mL is the usual starting strength used on this unit but 8mg/50mL and 16mg/50mL are also acceptable if appropriate.
- For peripheral use see separate monograph and associated advice on pages 54 - 57

ALFENTANIL INTENSIVE CARE (RAPIFEN)

PRESENTATION

1mL ampoules containing 5mg ALFENTANIL in 1mL

INDICATIONS

Potent analgesic and respiratory depressant for the management of ventilated patients on intensive care

RECONSTITUTION

Make 5 ampoules of alfentanil (5mg/mL) to 50 mL with infusion fluid (500micrograms/mL)

DILUENTS

5% glucose or 0.9% Sodium Chloride intravenous infusion

DOSE

0.5micrograms/kg/min by continuous intravenous infusion adjusted according to response (see table). Make sure a suitable range is prescribed e.g. 0 – 6mL/hr for a 50kg patient.

INITIAL INFUSION RATE (mL/hr) using alfentanil 25mg/50mL (500micrograms/mL)

Weight kg	Initial infusion rate ml/hr
40	2.4
50	3
60	3.6
70	4.2
80	4.8
90	5.4
100	6

NOTES

Alfentanil has an onset of action of 90 seconds and duration of 5 - 10 minutes
Effects of alfentanil can be reversed by naloxone

Take care! There are other strength preparations available

AMINOPHYLLINE

PRESENTATION

1 ampoule contains 250mg AMINOPHYLLINE in 10 ml (25mg/ml)

INDICATIONS

Reversible airways obstruction
Acute severe asthma

RECONSTITUTION

For intravenous bolus: use undiluted

For intravenous infusion: Dilute one ampoule (250mg) to 250mL with diluent to produce a 1mg/mL solution for infusion

DILUENTS

5% Glucose or 0.9% Sodium chloride intravenous infusion

DOSE

Loading dose (see table)

5mg/kg by slow IV injection over 20 minutes (**see table**)

Note: This should be prescribed on the back of the medication chart as a stat / once only medication

Do **NOT** prescribe a loading dose if currently treated with theophylline or aminophylline. Oral brands can include **Phyllocontin Continus®**, **Nuelin SA®**, **Slo-Phyllin®**, **Uniphyllin Continus®**

Maintenance dose (see table)

500microgram/kg/hour (Use lean body weight in obese patients)

NOTES

The prescription and administration of intravenous aminophylline should be clearly documented and communicated with all necessary staff. Monitor theophylline levels (active ingredient of aminophylline) six hours after the loading dose and once daily (range 10-20mg/Litre) whilst on the intravenous aminophylline infusion. Be aware of the potential for drug interactions and contact Pharmacy for advice if needed.

Record the date and time of each theophylline level in the nursing / medical notes.

Aminophylline loading dose (using 250mg/10mL undiluted)

Weight kg	LOADING DOSE (using 250mg/10mL) 5mg/kg over 20 minutes		
	Dose mg	Volume (mL) of AMINOPHYLLINE 250mg/10ml	Rate (mL/hour)
40	200	8	24
50	250	10	30
60	300	12	36
70	350	14	42
80	400	16	48
90	450	18	54
100	500	20	60

Aminophylline maintenance dose (using a diluted solution of 1mg/mL)

Weight kg	MAINTENANCE DOSE (using 1mg/mL) 500microgram/kg/hour
	Infusion rate AMINOPHYLLINE 250mg/250mL (mL/hour)
40	20
50	25
60	30
70	35
80	40
90	45
100	50

AMIODARONE

PRESENTATION

1 ampoule contains 150mg Amiodarone Hydrochloride in 3ml (50mg/mL)

INDICATIONS

Tachyarrhythmias

RECONSTITUTION (for IV infusion)

Add required dose of AMIODARONE to 50mL of 5% Glucose

DILUENT

Glucose 5% intravenous infusion only

DOSE (see table 1 overleaf)

Loading Dose: 5mg/kg made up to 50mL with 5% glucose by IV infusion over 60 minutes (i.e. rate = 50mL/hour). This should be prescribed on the back of the medication chart as a stat / once only medication. This may be followed by:

Maintenance Infusion: Doses of up to 1200mg (approx. 15mg/kg) made up to 50mL with 5% glucose by IV infusion over 24 hours (i.e. 2.1mL/hour)

NOTE: The maintenance infusion may be continued for longer than 24 hours depending on clinical situation

Should preferably be given via a central line to minimise the risk of thrombophlebitis. Monitor the injection site for signs of thrombophlebitis. Use only with cardiac monitor and where facilities exist for defibrillation

Converting to oral Amiodarone

If oral amiodarone is required long term, the following is an example of a suitable loading regimen.

200mg THREE times a day for 7 days then;

200mg TWICE a day for 7 days then

200mg ONCE a day thereafter.

Where necessary, it is recommended to continue the intravenous infusion for 24 hours after the first oral dose.

NOTES

The prescription and administration of intravenous amiodarone should be clearly documented and communicated with all necessary staff.

For long term therapy, check baseline LFT's and TFT's then 6-monthly thereafter. A baseline Chest X-ray should also be performed.

Volume (mL) of AMIODARONE 150mg/3ml required for dilution to 50mL with glucose 5%

Weight kg	5mg/kg dose Volume of Amiodarone (mL)	15mg/kg dose Volume of Amiodarone (mL)
40	4	12
50	5	15
60	6	18
70	7	21
80	8	24
90	9	24
100	10	24

ATRACURIUM (TRACRIUM)

PRESENTATION

1 ampoule contains 10mg ATRACURIUM BESILATE in 1mL
2.5mL, 5mL & 25mL ampoules available

INDICATIONS

Muscle relaxation during surgical procedure or controlled ventilation in intensive care

RECONSTITUTION (for IV infusion)

Draw 50mL of atracurium besilate into a 50mL syringe and use neat (10mg/mL)

DOSE (for tables, see overleaf)

1. Injection ^D

Duration of action is 15 - 30 minutes

0.5mg/kg by IV injection with second and subsequent doses of 0.1 - 0.2 mg/kg as required (**table 1**)

2. Infusion during prolonged surgical procedures ^D

Bolus dose of 0.5mg/kg by IV injection

Maintenance infusion of 0.3 - 0.6 mg/kg/hr (**table 2**)

Infusion should not be commenced until early spontaneous recovery from initial atracurim bolus is evident

3. Infusion during controlled ventilation in intensive care

Bolus dose of 0.5mg/kg by IV injection

Maintenance infusion of 0.65 – 0.78mg/kg/hr (**table 2**) rates of 1.77mg/kg/hr have been used

NOTES

If suxamethonium is used initially, you are recommended to consider waiting until there is evidence that this has worn off before administering atracurium

Drug of choice in renal and hepatic failure as the molecule is unstable at body pH and temperature

Rapidly reversed by neostigmine and atropine provided that sufficient time has elapsed after the last bolus dose or termination of the infusion (usually 20-35 minutes for bolus dose and 10-30 minutes for maintenance dose)

For tables, see over leaf

TABLE 1: INTRAVENOUS INJECTION (mL) using atracurium 10mg/ml (undiluted)

Weight kg	0.5mg/kg bolus dose Volume of atracurium required ml	0.1 – 0.2mg/kg dose Volume of atracurium required ml
40	2	0.4 – 0.8
50	2.5	0.5 – 1
60	3	0.6 – 1.2
70	3.5	0.7 – 1.4
80	4	0.8 – 1.6
90	4.5	0.9 – 1.8
100	5	1 - 2

TABLE 2: MAINTENANCE INFUSION (mL/hr) using atracurium 500mg/50 ml (undiluted)

Weight kg	0.3 – 0.6mg/kg/hr Infusion rate ml/hr	0.65 – 0.78mg/kg/hr Infusion rate ml/hr
40	1.2 - 2.4	2.6 – 3.1
50	1.5 - 3	3.3 – 3.9
60	1.8 - 3.6	3.9 – 4.7
70	2.1 - 4.2	4.6 – 5.5
80	2.4 - 4.8	5.2 – 6.2
90	2.7 - 5.4	5.9 – 7
100	3 - 6	6.5 – 7.8

CISATRACURIUM

PRESENTATION

1 vial contains 150MG CISATRACURRIUM in 30mL (5mg/mL)

Also available 2mg/mL (5mg/2.5mL, 10mg/5mL and 20mg/10mL vials)

INDICATIONS

As an adjunct to general anaesthesia or sedation in the Intensive Care Unit (ICU) to relax skeletal muscles, and to facilitate mechanical ventilation

RECONSTITUTION (for IV infusion)

Draw 30mL of cisatracurium into a 50mL syringe and use neat (5mg/mL)

DOSE (for tables, see over leaf)

The average infusion rate is 3 micrograms/kg/min (range 0.5 to 10.2 micrograms/kg/min)

NOTES

- If running at high rates can draw 300mg (60mL) up into a 50mL B-D syringe
- Cisatracurium may be an alternative to atracurium if histamine release unwanted (e.g. asthmatic patients)
- Cisatracurium should not be mixed in the same syringe or administered simultaneously through the same needle as propofol injectable emulsion or with alkaline solutions such as sodium thiopentone
- Contra-indicated in patients known to be hypersensitive to cisatracurium, atracurium, or benzenesulfonic acid.

INFUSION RATE (mL/hr) using 150mg/30mL
[starting dose and usual range]

Weight kg	Dose (micrograms/kg/min)				
	0.5		3		10
40	0.2	Titrate To affect within this range	1.4	Titrate To affect within this range	4.8
50	0.3		1.8		6
60	0.4		2.2		7.2
70	0.4		2.5		8.4
80	0.5		2.9		9.6
90	0.5		3.2		10.8
100	0.6		3.6		12



Usual starting rate (mL/hr)

CLONIDINE – Sedation and withdrawal syndromes ¹

PRESENTATION

1 ampoule contains 150micrograms CLONIDINE in 1ml (150micrograms/ml)

INDICATIONS

1. **Sedation (alone or as an adjunct)** – unlicensed (consider dexmedetomidine as licensed alternative)
2. **Treatment of fear, anxiety, sleep disturbances, due to withdrawal syndrome (opioids, benzodiazepines, alcohol)** – unlicensed

RECONSTITUTION

Dilute 5 ampoules (750microgram) to 50ml with diluent (15micrograms/ml)

DILUENTS

5% glucose intravenous infusion
0.9% Sodium Chloride intravenous infusion

DOSE (for both indications)

- Start at 2microgram/kg/hr and after 1 hour reduce to 1microgram/kg/hr
- Adjust in increments of 0.5micrograms/kg/hr every 2-3 hours thereafter if BP stable
- Aim to titrate between 0 and 2 micrograms/kg/hr with max dose 4micrograms/kg/hr
- When discontinuing, wean to 0.5micrograms/kg/hr and then stop
- If hypertension or agitation occur reduce rate more slowly or switch to oral/enteral at 50 – 100 micrograms tds and wean over 2-3 days

NOTES

- Common ADRs include bradycardia, hypotension, constipation
- Half life about 13hours in normal renal function
- Dose on **Ideal Body Weight**

INFUSION RATE (mL/hr) using Clonidine 750micrograms/50mL

IBW (kg)	Infusion rate (micrograms/kg/hr)						
	1	1.5	2	2.5	3	3.5	4
40	2.7	4	5.3	6.7	8	9.3	10.7
50	3.3	5	6.7	8.3	10	11.7	13.3
60	4	6	8	10	12	14	16
70	4.7	7	9.3	11.7	14	16.3	18.7
80	5.3	8	10.7	13.3	16	18.7	21.3
90	6	9	12	15	18	21	24
100	6.7	10	13.3	16.7	20	23.3	26.7


Starting dose


maximum dose

DEXMEDETOMIDINE (DEXDOR)

PRESENTATION

1 ampoule contains 100 micrograms DEXMEDETOMIDINE in 1mL (100micrograms/mL)

INDICATIONS

For sedation of adult ICU patients requiring a sedation level not deeper than arousal in response to verbal stimulation (corresponding to Richmond Agitation-Sedation Scale (RASS) 0 to -3)

RECONSTITUTION

Reconstitute to a concentration of 8 micrograms/ml:

Volume of Dexmedetomidine 100 micrograms/ml concentrate for solution for infusion	Volume of diluent	Total volume of infusion
4 ml	46 ml	50 ml
8 ml	92 ml	100 ml
20 ml	230 ml	250 ml
40 ml	460 ml	500 ml

DILUENTS

5% glucose intravenous infusion
0.9% Sodium Chloride intravenous infusion

DOSE and TITRATION

- Start at 0.7 microgram/kg/hr
 - Increase by increments of 0. 2 microgram/kg/hr every 15 minutes in order to achieve the desired level of sedation, depending on the patient's response
 - Max dose is 1.4 microgram/kg/hr
- When discontinuing Dexmedetomidine reduce infusion rate stepwise by 0.4microgram/kg/hr to 0.2microgram/kg/hr increments over a few hours and run until finished. If no withdrawal symptoms after 30 minutes, simply allow infusion to run out

Adjusting Other Sedative Infusions:

- Reduce propofol or other sedative infusions by 25-50% every 60-minutes until off
- Reduce opioid infusion rate by 25-50% every 60-minutes and titrate it to an acceptable pain score
- For patients with Acute Alcohol Withdrawal, continue the usual Benzodiazepine regimen, as Dexmedetomidine has no anti-convulsant properties

INFUSION RATE (mL/hour) using DEXMEDETOMIDENE 8 micrograms/mL

Actual body weight (Kg)	Dose in microgram/kg/hour												
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
50	1.2	1.9	2.5	3.1	3.8	4.4	5	5.6	6.3	6.9	7.5	8.1	8.8
55	1.4	2.1	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6
60	1.5	2.3	3	3.8	4.5	5.3	6	6.8	7.5	8.3	9	9.8	10.5
65	1.6	2.4	3.3	4.1	4.9	5.7	6.5	7.3	8.1	8.9	9.8	10.6	11.4
70	1.8	2.6	3.5	4.4	5.3	6.1	7	7.9	8.8	9.6	10.5	11.4	12.3
75	1.9	2.8	3.8	4.7	5.6	6.6	7.5	8.4	9.4	10.3	11.3	12.2	13.1
80	2	3	4	5	6	7	8	9	10	11	12	13	14
85	2.1	3.2	4.3	5.3	6.4	7.4	8.5	9.6	10.6	11.7	12.8	13.8	14.9
90	2.3	3.4	4.5	5.6	6.8	7.9	9	10.1	11.3	12.4	13.5	14.6	15.8
95	2.4	3.6	4.8	5.9	7.1	8.3	9.5	10.7	11.9	13.1	14.3	15.4	16.6



Starting dose



Maximum dose

NOTES

- If the heart rate decreases to 60 beats per minute or less, reduce the rate by 0.2 microgram/kg/hr
- Do not alter Dexmedetomidine rate during daily sedation holds
- A lower starting infusion rate should be considered for frail patients
- No loading or bolus dose

DOBUTAMINE

PRESENTATION

1 vial contains 250mg DOBUTAMINE in 20 ml (12.5 mg/ml)

INDICATION

Inotropic support in low output cardiac failure

RECONSTITUTION

Make 250mg (1 vial) up to 50ml with infusion fluid (5mg/ml)

DILUENTS

5% glucose intravenous infusion or 0.9% Sodium Chloride intravenous infusion

DOSE

2.5 - 10micrograms/kg/minute by continuous intravenous infusion (occasionally up to 40 micrograms/kg/min) (see table)

NOTES

Solution may turn pink – **NO** loss of potency

INFUSION RATE (mL/hr) using a Dobutamine 250mg/50mL solution (5mg/mL)

Weight (kg)	Dose (micrograms/Kg/min)											
	2.5	5	7.5	10	12.5	15	17.5	20	25	30	35	40
40	1.2	2.4	3.6	4.8	6	7.2	8.4	9.6	12	14.4	16.8	19.2
45	1.3	2.7	4.0	5.4	6.7	8.1	9.4	10.8	13.5	16.2	18.9	21.6
50	1.5	3	4.5	6	7.5	9	10.5	12	15	18	21	24
55	1.6	3.3	4.9	6.6	8.2	9.9	11.5	13.2	16.5	19.8	23.1	26.4
60	1.8	3.6	5.4	7.2	9	10.8	12.6	14.4	18	21.6	25.2	28.8
65	1.9	3.9	5.8	7.8	9.7	11.7	13.6	15.6	19.5	23.4	27.3	31.2
70	2.1	4.2	6.3	8.4	10.5	12.6	14.7	16.8	21	25.2	29.4	33.6
75	2.2	4.5	6.7	9.0	11.2	13.5	15.7	18	22.5	27	31.5	36
80	2.4	4.8	7.2	9.6	12	14.4	16.8	19.2	24	28.8	33.6	38.4
85	2.5	5.2	7.6	10.2	12.7	15.3	17.8	20.4	25.5	30.6	35.7	40.8
90	2.7	5.4	8.1	10.8	13.5	16.2	18.9	21.6	27	32.4	37.8	43.2
95	2.8	5.7	8.5	11.4	14.2	17.1	19.9	22.8	28.5	34	39.9	45.6
100	3	6	9	12	15	18	21	24	30	36	42	48


Normal dosage range

ENOXIMONE (PERFAN)

PRESENTATION

1 ampoule contains 100mg ENOXIMONE in 20ml (5mg/ml)

INDICATIONS

Congestive cardiac failure (especially where cardiac output reduced and filling pressures increased)

RECONSTITUTION

Make 1 ampoule (100mg) up to 40 ml with infusion fluid (2.5mg/ml)

DILUENTS

0.9% Sodium Chloride intravenous infusion

DOSE

1. **Initial – do not load** go straight to maintenance infusion
2. **Maintenance**
Start at 5 micrograms/kg/hour. Usual range 5 - 20 micrograms/kg/min by continuous IV infusion (see table over leaf)

NOTES

- Use with caution in patients with heart failure associated with hypertrophic cardiomyopathy, stenotic or obstructive valvular disease or other outlet obstruction
- Incompatible with glucose solutions
- Use only plastic containers or syringes; crystal formation if glass used
- Avoid extravasation
- Do not use more dilute solutions

Maintenance infusion rate (mL/hour) using ENOXIMONE 100mg/40ml solution (2.5mg/ml)

Weight (kg)	DOSE (microgram/kg/min)		
	5		20
40	4.8	Usual range - Titrate to effect	19.2
50	6		24
60	7.2		28.8
70	8.4		33.6
80	9.6		38.4
90	10.8		43.2
100	12		48


 Starting dose

EPOPROSTENOL (FLOLAN® with pH 12 solvent)

PRESENTATION

1 ampoule contains 500 micrograms EPOPROSTENOL

INDICATIONS

Epoprostenol is indicated for use in renal dialysis when use of heparin carries a high risk of causing or exacerbating bleeding or when heparin is otherwise contra-indicated

It is given by continuous infusion, either intravascularly or into the blood supplying the dialyser

RECONSTITUTION

Ideally reconstitution should be carried out immediately prior to use. Only the solvent provided for the purpose should be used. The enclosed filter unit must be used once only and then discarded after use.

1. Withdraw approximately 10 ml of the solvent into a sterile syringe.
2. Inject the contents of the syringe into the vial containing epoprostenol and shake gently until the powder has dissolved.
3. Draw up all the epoprostenol solution into the syringe.
4. Re-inject the entire contents into the remaining volume of the original 50 ml of solvent.
5. Mix well. This solution is now referred to as the *concentrated solution* and contains epoprostenol 10,000 nanograms/mL.
6. The filter provided should then be attached to a 50mL syringe and 10mL of the *concentrated solution* drawn up.
7. Remove the filter and draw up 40 mLs 0.9% NaCl into the syringe. The resultant 50mL solution has a concentration of 2,000 nanograms/mL
8. Discard any remaining *concentrated solution*. The filter should only be used once. Discard final solution if any discolouration or particles are observed.

DILUENTS

Initial reconstitution should be with the solvent provided.

Further dilution of the *concentrated solution* should be done with 0.9% NaCl

Other common intravenous fluids are unsatisfactory for the dilution of the *concentrated solution* as the required pH is not attained

DOSE

For 15 minutes prior to dialysis: 4 nanogram/kg/min intravenously.

During dialysis: 4 nanogram/kg/min into the arterial inlet of the dialyser.

The infusion should be stopped at the end of dialysis.

INFUSION RATE (mL/hr) using epoprostenol 2,000 nanograms/mL solution

Dosage nanogram/kg/min	Weight (kg)							
	30	40	50	60	70	80	90	100
4	3.60	4.80	6.00	7.20	8.40	9.60	10.80	12.00

NOTES

Epoprostanol infusion solutions will retain 90% of their initial potency for approximately 12 hours at 25°C

ERYTHROMYCIN (as lactobionate)

PRESENTATION

1 ampoule contains 1g of ERYTHROMYCIN lactobionate dry powder

INDICATION

As first line prokinetic (refer to section on prokinetics, page 36)

RECONSTITUTION

- 1g of erythromycin should be diluted to 20mL with Water for Injection
- Remove 4mL (200mg) and make up to 50mL with infusion fluid
- Remaining solution can be stored between 2 - 8°C for up to 24 hours

DILUENT

0.9% NaCl intravenous infusion

DOSE

200mg over 20minutes every 8 hour up to a maximum of 3 doses (see prokinetics protocol on page 36)

NOTES

1. Caution required if patient is pro-arrhythmogenic or receiving Amiodarone, haloperidol, imidazole anti-fungal agents (e.g. fluconazole), verapamil, diltiazem or HIV protease inhibitors
2. Risk of QTc prolongation

KETAMINE - for the management of asthma or Bronchospasm

PRESENTATION

1 vial contains 500mg KETAMINE in 10mL (50mg/mL)

Also available 1000mg (100mg/mL; 10mL vial) and 200mg (10mg/mL; 20mL vial)

INDICATIONS

Management of severe asthma or bronchospasm in invasively ventilated patients

RECONSTITUTION

Dilute 500mg (one vial of 50mg/mL) to 50mL with diluent (10mg/mL)

DILUENTS

5% Glucose infusion
0.9% Sodium Chloride

DOSE

Start at 500 micrograms to 1mg/kg/hr
Increase gradually according to affect
Maximum dose 2.5mg/kg/hr
(see table overleaf)

Notes on dosing and administration

1. Dose using actual body weight
2. Start at 500micrograms/kg/hr if patient has history of cardiovascular disease (including hypertension and/or sinus tachycardia)
3. Ketamine can be administered centrally or peripherally

INFUSION RATE (mL/hr) using ketamine 10mg/mL

Weight kg	Dose (mg/kg/hr)				
	0.5	1	1.5	2	2.5
40	2	4	6	8	10
45	2.2	4.5	6.7	9	11.2
50	2.5	5	7.5	10	12.5
55	2.7	5.5	8.2	11	13.7
60	3	6	9	12	15
65	3.2	6.5	9.7	13	16.2
70	3.5	7	10.5	14	17.5
75	3.7	7.5	11.2	15	18.7
80	4	8	12	16	20
85	4.2	8.5	12.7	17	21.2
90	4.5	9	13.5	18	22.5
95	4.7	9.5	14.2	19	23.7
100	5	10	15	20	25

Usual starting rate (mL/hr)

References

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METOCLOPRAMIDE

PRESENTATION

1 ampoule contains 10mg of METOCLOPRAMIDE in 2mL (5mg/mL)

INDICATIONS

1. Second line prokinetic (refer to section on prokinetics, page 36)
2. Management of nausea and vomiting

RECONSTITUTION

Use undiluted

DILUENTS

Use undiluted

DOSE

1. 10mg tds over at least 3 minutes for 48 hours (see prokinetics protocol on page 36)
2. 10mg when necessary over at least 3 minutes 6 – 8 hourly (maximum dose 30mg/24 hours but see notes)

NOTES

1. Maximum of 5 days regular therapy (to minimise the known risks of potentially serious neurological side effects).
2. Can go up to a maximum dose of 120mg/24 hours in palliative care

MIDAZOLAM (adjuvant sedative)

PRESENTATION

1 vial contains 50mg of MIDAZOLAM in 50ml (1mg/ml)

INDICATION

Sedation of a ventilated patient in intensive care – adjuvant/second line (for other indications refer to the Summary of Product Characteristics)

RECONSTITUTION(For IV infusion)

Use undiluted vial 50mg in 50ml

DILUENTS

Use undiluted vial 50mg in 50ml

DOSE

Sedation in intensive care in ventilated patients (in conjunction with propofol)

Start at 1mL/hr and titrate according to the prescribed target RASS, usual maximum rate 5mL/hr (can go above this at consultants' discretion)

MILRINONE

PRESENTATION

1 ampoule contains 10mg MILRINONE in 10ml (1mg/ml)

INDICATIONS

1. Short-term treatment of severe congestive heart failure unresponsive to conventional maintenance therapy
2. The treatment of patients with acute heart failure, including low output states following cardiac surgery

RECONSTITUTION

Make one ampoule (10mg) up to 50mL with infusion fluid (200micrograms/mL)

DILUENTS

Sodium chloride 0.9% or glucose 5%

DOSE

Maintenance dose (no loading dose required, table 1 over leaf):

Start at 0.375microgram/kg/min and titrate up to a maximum of 0.75 microgram /kg/min

NOTES

- Lower doses may be required in renal impairment (CrCl<50mL/min)
- Furosemide or bumetanide should not be administered in intravenous lines containing Milrinone Injection since precipitation occurs on admixture.
- Sodium Bicarbonate Intravenous infusion should not be used for dilution.

Maintenance infusion rate (**mL/hour**) using MILRINONE 10mg/50mL solution
(200micrograms/mL)

Weight kg	Dose (micrograms/kg/min)		
	0.375	Usual range - Titrate To affect	0.75
40	4.5		9
50	5.6		11.3
60	6.8		13.5
70	7.9		15.8
80	9		18
90	10.1		20.3
100	11.3		22.5

MORPHINE

PRESENTATION

10mg/mL, 60mg/2mL, 100mg/50mL prefilled syringe

INDICATIONS

- 1) **Control of severe pain**
- 2) **Patient controlled analgesia (PCA)**
- 3) **Analgesia in ventilated patients (First line)**

RECONSTITUTION

- 1) **Control of severe pain** - See under dose
- 2) **Patient controlled analgesia (PCA)** - Use 100mg morphine in 50mL 0.9% NaCl prefilled syringes (i.e. 2mg/mL)
- 3) **Analgesia in ventilated patients** - Dilute 60mg morphine to 60mL with 5% Glucose (i.e. 1mg/mL)

DILUENTS

- 1) **Control of severe pain** - 0.9% Sodium Chloride
- 2) **Patient controlled analgesia (PCA)** - Prefilled syringe (0.9% Sodium Chloride)
- 3) **Analgesia in ventilated patients** - 5% glucose or 0.9% Sodium Chloride

DOSE (for all indications)

1) Control of severe pain

0.15mg/kg by IV injection ^D

Dilute required volume to 10mL with 0.9% Sodium chloride and give 3-4mL by IV injection followed by 1mL boluses and titrate to effect ^D

2) Patient controlled analgesia (PCA)

Bolus 1mg, lockout 5minutes (bolus dose can be altered according to patients' requirements)

Monitor respiration, sedation and pain hourly for 24 hours post operatively then 4 hourly

3) Analgesia in ventilated patients

Initially 2-4mg/hr, alter according to response ^D

Remember to monitor pain and sedation scores as appropriate

NOTES

Reversed by naloxone

Theoretical risk of increased intraluminal pressure when used for visceral pain

NORADRENALINE

PRESENTATION

Ampoule contains 4mg NORADRENALINE base in 4ml (1mg/ml)

INDICATION

To elevate blood pressure in SIRS and septic shock

RECONSTITUTION (For IV infusion)

Dilute 8mg (8mL) to 50mL with diluent (160micrograms/mL)

DILUENTS

5% glucose intravenous infusion

DOSE

Start at 1 - 5mL/hr of 8mg/50mL and titrate to the patient's pre-determined targets based on condition being treated using the parameters listed below. For high infusion rates use a more concentrated solution (see **NOTES**). **Usual range up to 20mL/hr** of any of the suggested concentrations.

- Adjust dose according to CO, HR, BP, MAP and/or urine output
- Ensure adequate intravascular volume replacement before initiating vasopressors
- Do not give without invasive haemodynamic monitoring (e.g. blood pressure monitoring. Consider monitoring with a PICCO)

NOTES

- 1) 8mg/50mL is the usual starting strength used on this unit but 4mg/50mL, 16mg/50mL and 32mg/50mL are also acceptable if appropriate.

PHENYTOIN SODIUM

PRESENTATION

1 ampoule contains 250mg Phenytoin Sodium in 5mL (50mg/mL)

INDICATIONS

- 1) Control of status epilepticus
- 2) Maintenance therapy in patients where the enteral route is unavailable

DOSE

Each dose should be preceded & followed by an injection of sodium chloride 0.9% to prevent venous irritation. Inject into a large vein through a large gauge needle or intravenous catheter. Continuous monitoring of ECG, blood pressure and for signs of respiratory depression is essential during administration of intravenous phenytoin by either a doctor or other staff member familiar with ECG interpretation. The patient can be monitored with a defibrillator using the cardiac arrest trolley or a portable defibrillator. Where ECG changes are observed (bradycardia, AV block, wide QRS, ventricular arrhythmias, asystole), reduce the rate or discontinue the infusion.

1) Initial Loading dose for ADULT patients with status epilepticus

15 - 20 mg/kg loading dose given intravenously UNDILUTED via a suitable INFUSION PUMP.

Infuse at a rate NOT exceeding 50mg/min (60mL/hour) of undiluted phenytoin. Lower rates of 25mg/min (30mL/hour) or less may be appropriate in some patients (eg. in the elderly or those with a history of cardiac disease).

The loading dose should be followed by a maintenance dose as described below. For patients currently on Phenytoin a lower loading dose (or none) may be required - obtain an urgent phenytoin level and contact Pharmacy for advice.

2) Maintenance dose in ADULTS

100mg (2mL) given intravenously, undiluted, by slow injection over at least 2 minutes (1mL/min) every 6 - 8 hours if necessary. Administer over at least 4 minutes in the elderly or patients with a history of cardiac disease. When the patient can tolerate oral medication, convert to oral phenytoin (e.g. 300mg capsules at night) where possible. Patients with low albumin levels may require lower doses, contact Pharmacy for advice.

SECOND CHECK BY ANOTHER REGISTERED PRACTITIONER IS REQUIRED FOR ALL CALCULATIONS, PREPARATION AND ADMINISTRATION

PREGNANCY

Has been associated with birth defects, assess benefit vs risk

MONITORING/NOTES

1. The patient must be monitored continuously during the infusion, including ECG, blood pressure and for signs of respiratory depression
2. ECG can be monitored with a defibrillator using the cardiac arrest trolley or a portable defibrillator
3. If ECG changes are observed (bradycardia, AV block, wide QRS, ventricular arrhythmias, asystole), reduce the rate or discontinue the infusion.

4. Diluted infusions – not recommended Trust policy. Strict requirements for maximum concentration, use by time, in-line filters result in higher risk score than use of undiluted injection
5. Check phenytoin levels 6-24 hours after the loading dose. Target phenytoin levels are 10-20mg/L. A pre level is required when monitoring maintenance dose
6. 100mg of oral phenytoin capsules is approximately equivalent to 100mg intravenous phenytoin which is approximately equivalent to 90mg of Phenytoin suspension
7. The prescription and administration of phenytoin should be clearly documented and communicated with all necessary staff.

Table 1: DOSE (mg) and VOLUME (mL) of phenytoin 250mg/5mL required undiluted to provide either a 15mg/kg or a 20mg/kg loading dose

REMINDER – give loading dose via an INFUSION PUMP at a rate no faster than 50mg/min. A slower rate of 25mg/min or less is appropriate in some patients such as in the elderly or those with a history of cardiac disease.

Weight (kg)	15mg/kg dose		20mg/kg dose	
	Dose (mg)	Volume of phenytoin (mL)	Dose (mg)	Volume of phenytoin (mL)
40	600	12	800	16
45	675	13.5	900	18
50	750	15	1000	20
55	825	16.5	1100	22
60	900	18	1200	24
65	975	19.5	1300	26
70	1050	21	1400	28
75	1125	22.5	1500	30
80	1200	24	1600	32
85	1275	25.5	1700	34
90	1350	27	1800	36
95	1425	28.5	1900	38
100	1500	30	2000	40

For cautions, contra-indications, side effects and drug interactions see the emergency prescribing handbook full monograph

<http://nww.sthk.nhs.uk/services/Emergency%20Care/Documents/Phenytoin%20Nov%202017%20VERSION%202.4.pdf>

SECOND CHECK BY ANOTHER REGISTERED PRACTITIONER IS REQUIRED FOR ALL CALCULATIONS, PREPARATION AND ADMINISTRATION

PROPOFOL 1%

PRESENTATION

1 vial contains 1000mg Propofol in 100mL (10mg/mL)

Also available as an ampoule containing 200mg PROPOFOL in 20mL (10mg/mL)

INDICATIONS

- 1. Sedation for surgical and diagnostic procedures (not to be administered by the operator)**
- 2. Sedation in intensive care**

RECONSTITUTION

Use undiluted (withdraw required amount into syringe if necessary)

DOSE

1. Sedation for surgical and diagnostic procedures

0.5 – 1mg/kg over 1 – 5 minutes for onset of sedation (titrate rate of administration to clinical response). Sedation can be maintained by titrating infusion to desired clinical response (usual range 1.5 – 4.5mg/kg/hr)

2. Sedation in intensive care^D

- **Start at 5mls/hr** and titrate according to the prescribed target RASS. (Usual range 0.3 - 4mg/kg/hr)
- **Usually prescribed as a range of 0-20mL/hour**
- **If required can be prescribed up to a maximum of 4mg/kg/hr e.g. for a 70 kg patient up to 28mL/hr**

NOTES

- No analgesic action (prescribe suitable analgesia if required)
- Licensed for up to 3 days use, use sedation scoring tool (see nursing documentation)
- Do not give atracurium through the same line

RANITIDINE **

PRESENTATION

1 ampoule contains 50mg of RANITIDINE in 2mL (25mg/mL)

INDICATIONS

Prophylaxis of GI haemorrhage from stress ulceration in critical care patients

RECONSTITUTION

50mg of ranitidine should be diluted to 20mL with diluent

DILUENTS

5% glucose intravenous infusion

0.9% Sodium Chloride

DOSE

50mg by slow IV injection (over 2 minutes) every 8 hours

**** May 2020 - Currently unavailable****

**Use Pantoprazole 40mg iv daily in 100mL 0.9% NaCl over 15 mins
instead for stress ulcer prophylaxis**

REMIFENTANIL – Additional analgesia during dressing changes in a ventilated burns/plastics patients

PRESENTATION

1 vial contain either 1, 2 or 5mg REMIFENTANIL as dry powder for reconstitution

INDICATION

Additional analgesia during dressing changes in a ventilated burns/plastics patients

RECONSTITUTION

Dilute to 100micrograms/mL with diluent. For example 5mg/50mL (standard dilution) or 4mg/40mL

DILUENTS

5% glucose intravenous infusion or 0.9% sodium chloride intravenous infusion

DOSE (Idea Body Weight)

Additional analgesia for ventilated burns/plastics patients undergoing dressing's changes

- Initially a rate of at least 0.1micrograms/kg/min should be maintained for at least 5minutes prior to the start of the procedure
- Further dose adjustments may be made every 2 to 5 minutes in increments of 25%-50%
- Usual maintenance of 0.25micrograms/kg/min
- Usual maximum rate 0.75micrograms/kg/min (can go above this at consultants' discretion)
- Can be abruptly stopped. Make sure patient has adequate alternative analgesia on board in necessary e.g. morphine bolus
- Do not give bolus doses.**

INFUSION RATE (mL/hr) using Remifentanyl 100micrograms/mL

Idea Body Weight (kg)	Infusion rate (micrograms/kg/min)				
	0.1	Titrate to effect Increase in 25% - 50% increments	0.25	Titrate to effect Increase in 25% - 50% increments	0.75
40	2.4		6		18
50	3		7.5		22.5
60	3.6		9		27
70	4.2		10.5		31.5
80	4.8		12		36
90	5.4		13.5		40.5
100	6		15		45
	↑ Starting dose		↑ Suggested maintenance		↑ Usual maximum

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REMIFENTANIL – analgesia/sedation in ventilated patients

PRESENTATION

1 vial contains either 1, 2 or 5mg REMIFENTANIL as dry powder for reconstitution

INDICATION

Analgesia and sedation in ventilated intensive care patients

RECONSTITUTION

Dilute to 100micrograms/mL with diluent. For example 5mg/50mL (standard dilution) or 4mg/40mL

DILUENTS

5% glucose intravenous infusion or 0.9% sodium chloride intravenous infusion

DOSE (Idea Body Weight)

Analgesia and sedation in ventilated intensive care patients

- Initially 0.1 micrograms/kg/min
- Adjust according to response in increments of 0.025microgram/kg/min
- Allow at least 5 minutes between dosage adjustments
- Sedation - If an infusion rate of 0.2micrograms/kg/min is reached and patient not adequately sedated consider adding an appropriate sedative agent e.g. propofol
- Analgesia – further increases of 0.025microgram/kg/min may be made if additional analgesia required
- Can abruptly stop at end of procedure. Make sure patient has adequate alternative analgesia on board e.g. morphine bolus/infusion
- Do not give bolus doses**

INFUSION RATE (mL/hr) using Remifentanil 100micrograms/mL

Idea Body Weight (kg)	Infusion rate (micrograms/kg/min)				
	0.1		0.2		0.275
40	2.4	Titrate to effect	4.8	Titrate to effect	6.6
50	3		6		8.2
60	3.6		7.2		9.9
70	4.2	Increase in 25% - 50% increments	8.4	Increase in 25% - 50% increments	11.5
80	4.8		9.6		13.2
90	5.4		10.8		14.8
100	6		12		16.5

↑
Starting dose

↑
(if not adequately sedated at this point add in second agent)

↑
Usual max dose

Information continued over leaf

Additional analgesia for ventilated patients undergoing stimulating procedures

- An increase in the existing remifentanyl infusion rate may be required to provide additional analgesic cover for ventilated patients undergoing stimulating and/or painful procedures such as endotracheal suctioning, wound dressing and physiotherapy
- It is recommended that a remifentanyl infusion rate of at least 0.1 microgram/kg/min should be maintained for at least 5 minutes prior to the start of the stimulating procedure
- Further dose adjustments may be made every 2 to 5 minutes in increments of 25%-50% in anticipation of, or in response to, additional requirement for analgesia
- A mean infusion rate of 0.25 microgram/kg/min, maximum 0.75 microgram/kg/min has been administered for provision of additional analgesia during stimulating procedures

Establishment of alternative analgesia prior to discontinuation

- Due to the very rapid offset of action, no residual opioid activity will be present within 5 to 10 minutes after discontinuation regardless of the duration of infusion
- Prior to discontinuation, patients must be given alternative analgesic and sedative agents at a sufficient time in advance to allow the therapeutic effects of these agents to become established
- If opioid analgesia is required, a suitable dose of morphine should be given 30 minutes before discontinuation of remifentanyl.

Guidelines for extubation and discontinuation of remifentanyl

- Titrate remifentanyl in stages to 0.1 microgram/kg/min over a period up to 1 hour prior to extubation.
- Following extubation, the infusion rate should be reduced by 25% decrements in at least 10-minute intervals until the infusion is discontinued
- During weaning from the ventilator the remifentanyl infusion should not be increased and only down titration should occur, supplemented as required with alternative analgesics.
- Upon discontinuation of remifentanyl, the IV cannula should be cleared or removed to prevent subsequent inadvertent administration.
- When other opioid agents are administered as part of the regimen for transition to alternative analgesia, the patient must be carefully monitored. The benefit of providing adequate analgesia must always be balanced against the potential risk of respiratory depression.

ROCURONIUM

PRESENTATION

1 ampoule contains 10mg ROCURONIUM in 1ml (10mg/ml)

INDICATIONS

As an adjunct to general anesthesia or sedation in the Intensive Care Unit (ICU) to relax skeletal muscles, and to facilitate mechanical ventilation

RECONSTITUTION

Dilute 250mg to 50ml with diluent (5mg/ml)

DILUENTS

Sodium chloride 0.9% or glucose 5%

NOTES

- Use adjusted body weight for overweight/obese patients (if >30% IBW)
- Use with caution in patients with clinically significant hepatic and/or biliary diseases and/or renal failure

DOSE

Maintenance dose

300-600 micrograms/kg/hour by intravenous infusion adjusted according to response

INFUSION RATE (mL/hour) using ROCURONIUM 250mg/50mL solution (5mg/mL)

Weight kg	Dose (micrograms/kg/hour)		
	300		600
40	2.4	Titrate To affect within this range	4.8
50	3		6
60	3.6		7.2
70	4.2		8.4
80	4.8		9.6
90	5.4		10.8
100	6		12

Synthetic VASOPRESSIN (Argipressin)

PRESENTATION

1 vial contains 20units of ARGIPRESSIN (synthetic vasopressin) in 1 mL (20units/mL)

INDICATION

Severe sepsis with refractory shock (increasing doses of inotropes and adequate fluid resuscitation undertaken)

RECONSTITUTION

Dilute 20units (1mL) to 50mL with diluent (0.4unit/mL)

DILUENTS

5% glucose intravenous infusion

0.9% sodium chloride intravenous infusion (unlicensed)

DOSE

- Start at 1.8units/hr (**4.5mL/hr**)
- Reduce dose to 0.9units/hr (**2.2mL/hr**) once Noradrenaline rate is equivalent to 5mL/hr or less of 8mg/50mL
- Stop once Noradrenaline rate is equivalent to 2.5mL/hr or less of 8mg/50mL

NOTES

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Peripheral Vasopressors

Guidance for the usage of vasopressors via peripheral infusion

****Critical care use only****

Background

Vasopressors/vasoconstrictors (from now on referred to as “vasopressors”) are an integral part of the management of patients with septic shock. They are traditionally given via a central venous catheter (“central line”/CVC) due to the risk of tissue injury and necrosis if extravasation were to occur.

Under certain circumstances the administration of vasopressors via a peripheral venous cannula (PVC) may be the safest and most timely way of supporting a patient’s blood pressure.

The following lays out guidance for identifying suitable patients, states safe practices and provides medicines information in the form of monographs

Indication for peripheral vasopressor

- 1) As a holding measure until a CVC can be safely inserted
- 2) For short term management of hypotension for example in the post-operative period

Who can initiate/manage peripheral vasopressors

Any trainee can use vasopressors via a PVC until the CVC is inserted and safe to use or until the vasopressor is weaned off.

Acceptable duration of infusion of vasopressor via a PVC

There is no suggested acceptable duration of administration defined in the literature although the median time stated in the referenced studies is 6-15 hours.

1. For the purposes of this guidance a maximum infusion time of 12 hours should elapse before the consultant on call is informed that a patient is being managed on a peripheral vasopressor.
2. The consultant on-call must review the patient within 12 hours of commencement of PVC vasopressor and then at least every 24 hours after that.
3. If applicable, PVC should be changed at 72 hours

PVC size and site

There seems to be no strong evidence to suggest a link between choice of site for peripheral venous line and extravasation event. However, the studies reference below did employ some common sense guidance on choice of size and site of PVC:

- Choose at least a 20G PVC size
- Locate in a site in the arm, proximal to the wrist
- Avoid sites in the antecubital fossa and veins next to joints, tendons, nerves or arteries
- Avoid sites requiring more than 1 venepuncture
- Ensure there is return of blood following insertion of the PVC and that the PVC flushes easily with 5-10mL of 0.9% sodium chloride
- Site a second PVC in case of failure of primary site (this is not necessary if a CVC is being inserted)

Extravasation (inc. treatment)

In the studies referenced the incidence of extravasation is low with a rate ranging from 2 to 5.5%. There was no documented tissue injury or need for surgical intervention.

There is no specific indicated therapy in the event of extravasation but

- The PVC should be removed and re-sited
- Or a CVC should be inserted
- A topical vasoactive agent can be applied e.g. nitroglycerin paste
- Seek surgical/plastics opinion if applicable

Choice of agent

Although numerous agents have been reviewed in the literature, the senior clinical team at Whiston Critical Care Unit (4E) have decided to use the following three agents based on their own practical experience and knowledge of these agents

****vasopressors should be administered on their own via a dedicated cannula****

Metaraminol

Presentation

Metaraminol 10mg/mL Solution for injection or infusion

Indication

- 1) As a holding measure until a CVC can be safely inserted
- 2) For short term management of hypotension for example in the post-operative period

Reconstitution

Dilute 20mg Metaraminol (2mL of Metaraminol 10mg/mL) to 40mL with diluent (500microgram/mL)

Dilution

0.9% sodium chloride injection or 5% glucose

Method of Administration & Dose

Administer via an infusion pump at a rate up to 10mg/hour (20mL/hour of 500microgram/mL)

Special Considerations

- 1) After discontinuation, flush the peripheral cannula with sodium chloride 0.9% at the same rate the medicine was infused to avoid adverse haemodynamic effects
- 2) Change the syringe every 24 hours
- 3) On set of action is around 1 – 2 minutes and a single dose lasts from 20 minutes to 1 hour. There is no need to piggyback infusions
- 4) pH 3.4 when 20mg metaraminol diluted to 40mL with 0.9% NaCl, extravasation is likely to cause local tissue injury

Adrenaline

Presentation

Adrenaline 1mg/mL Solution for injection or infusion

Indication

- 1) As a holding measure until a CVC can be safely inserted
- 2) For short term management of hypotension for example in the post-operative period

Reconstitution

Dilute 4mg adrenaline (4mL of adrenaline 1mg/mL) to 250mL of diluent (16microgram/mL)

Dilution

5% glucose (preferred) or 0.9% sodium chloride

Method of Administration & Dose

Administer via an infusion pump at a rate up to 8micrograms/kg/hour. Practically this is a maximum rate of

- 25mL/hour for a 50kg patient
- 35mL/hour for a 70kg patient

Special Considerations

- 1) After discontinuation, flush the peripheral cannula with sodium chloride 0.9% at the same rate the medicine was infused to avoid adverse haemodynamic effects
- 2) Change the syringe every 24 hours
- 3) Adrenaline has a very short half-life so piggyback of infusion is required
- 4) pH low, extravasation is likely to cause local tissue injury

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Electrolyte Replacement

ELECTROLYTE REPLACEMENT^D

POTASSIUM^D

Intravenous

PLEASE REFER TO THE FOLLOWING,
"Protocol for the administration of Strong Potassium Chloride (KCl)" on ICU
"Water and electrolyte fluids in Critical Care" (Crit. Care maintenance fluid policy)
"Trust potassium policy"

General guidance: 1mmol/kg body weight/daily is required to MAINTAIN serum potassium level.
Take this into consideration when prescribing background/maintenance fluids

Enteral

Use either
Sando K (12mmol/tablet) e.g. 3 tablets 3 times a day
Kay-Cee-L (1mmol/mL) e.g. 20mL 3 or 4 times a day

Select a dose appropriate for the current serum potassium and the target level.

To see a rise in serum potassium of 1 mmol (e.g. from 3.0 to 4.0) requires 100 – 200 mmol of potassium to be administered

MAGNESIUM^D

Intravenous

Presentation/reconstitution: Use Magnesium Sulphate 5g (20mmol)/10mL ampoules and dilute with 0.9% Sodium Chloride or 5% Glucose as described below

Dose: see below

Serum Magnesium	Dose and reconstitution	
Less than 0.7mmol/L	Via central line: 20mmol made up to 50mL with diluent and given over 2 hours at 25mL/hour	Recheck level about 4 hours after end of infusion
	Via peripheral cannula: 20mmol made up to 100mL with diluent and given over 2 hours at 50mL/hour	

Enteral

Magnesium Aspartate 10mmol sachets; consider a dose of 10mmol/1 sachet 2 or 3 times daily

CALCIUM^D

Intravenous

Presentation/reconstitution: Use Calcium **Gluconate** 10% ampoules undiluted.

Dose: Dependent on serum Corrected Calcium levels (see table overleaf)

Serum <u>Corrected</u> Calcium	Dose	Recheck level about 4 hours after end of infusion
2.0 – 2.15 mmol/L	Give 20mL undiluted over 1 hour	
Less than 2.0 mmol/L	Give 40mL undiluted over 1 hour	

Note – 30mL calcium gluconate 10% ≈ 10mL calcium chloride 10% (i.e. not equivalent)

Enteral

Cacit tablets; start with a dose of 1 tablet twice daily

PHOSPHATE^D

Intravenous

FIRST LINE Presentation/reconstitution: Use Mixed Phosphates (Fresenius polyfuser phosphate infusion 50mmol/500mL)

Dose: Dependent on serum Phosphate levels (see table below)

Serum Phosphate	Dose	Recheck level about 4 hours after end of infusion
0.4 – 0.7 mmol/L	Give 200ml over 4 hours at 50mL/hr	
Less than 0.4 mmol/L	Give 400ml over 4 hours at 100mL/hr	

SECOND LINE Presentation/reconstitution: Use Sodium Glycerophosphate 21.6% (Glycophos) diluted with glucose 5% as below

Dose – Dependent on serum phosphate levels (see table below)

Serum Phosphate	Dose	Recheck level about 4 hours after end of infusion
0.4 – 0.7 mmol/L	Dilute 20mmol (1 vial) to 100mL with diluent and give over 4 hours (25mL/hr)	
Less than 0.4 mmol/L	Dilute 40mmol (2 vials) to 100mL with diluent and give over 4 hours (25mL/hr)	

Enteral

Phosphate Sandoz; start at 2 tablets three times a day

Antibiotics

Drug	Standard IV Dose (normal renal function)	Route and Directions	Reconstitution & Further Dilution	Diluent	Notes
Antibacterial ** Where able consider gravity infusion/bolus dosing to reduce burden on pumps ** IV bolus is over at least 3 mins, infusion over 30 minutes unless otherwise stated					note: WFI = Water for Injection
					G = 5% Glucose
					N = 0.9% NaCl
Amoxicillin	500mg - 1g 8h	IV bolus	500mg = 10mL 1g = 20mL	WFI	Severe infections up to 1g 6 hourly Listeria meningitis 2g 4 hourly
		IV infusion	100mL	G or N (minibag plus)	
Benzylpenicillin	2.4-4.8g daily 4 divided doses (see notes)	IV bolus (if >1.2g = 300mg/min)	600mg = 10mL 1.2g = 20mL	WFI or N	1) Meningococcal meningitis 2.4g 4 hourly 2) Streptococcal endocarditis 1.2g 4 hourly
		IV infusion	100mL	G or N (minibag plus)	
Cefotaxime	1g 12h (see notes)	IV bolus	1g = 4mL 2g = 10mL	WFI	Severe infections e.g. meningitis 2g 6 hourly (up to 3g 6 hourly may be required)
		IV infusion	50mL	G or N (minibag plus)	
Ceftazidime	1g 8h or 2g 12h	IV bolus	10mL	WFI	In severe infections can use 2g 8 to 12 hours or 3g 12 hourly
Ceftriaxone	1g daily (see notes)	IV bolus over 5 minutes	1g = 10mL 2g = 20mL	WFI	1) 2-4g daily in severe infections 2) Up to 2g may be given by IV bolus injection.
Cefuroxime	750mg - 1.5g 8h	IV bolus	750mg = 6mL 1.5g = 15mL	WFI	If prescribed Metronidazole, can be added to Flagyl Plus
		IV infusion	50mL	G or N (minibag plus)	

Drug	Standard IV Dose (normal renal function)	Route and Directions	Reconstitution & Further Dilution	Diluent	Notes
Clarithromycin	500mg 12h	IV infusion over 60 mins into a large proximal vein	Dissolve initially in WFI (500mg in 10mL) then dilute to 2mg/mL (i.e. 500mg in 250mL)	G or N	1) Unsuitable for IV bolus
Clindamycin	1.2g 6h	IV infusion over 60 mins	100mL	G or N	1) Lower doses can be used in less severe infections 2) Unsuitable for IV bolus
Co-amoxiclav	1.2g 8h	IV bolus	20mL	WFI	
		IV infusion	100mL	N (minibag plus)	
Co-trimoxazole	960mg 12h (see notes)	Infusion over 60 - 90 min.	1 amp = 125mL 2 amp = 250mL 3 or 4 amp = 500mL	G	1) 1 amp = 480mg/5mL 2) Fluid restricted – dilute each amp with 75mL & give over max 60min 3) Undiluted via a central line over 90-120mins 4) Treatment of Pneumocystis carinii 120mg/kg daily in 2-4 divided doses
Flucloxacillin	250mg - 2g 6h	IV bolus (2g over 6 mins)	250mg & 500mg = 10mL 1g = 20mL 2g = 40mL	WFI	
		IV infusion over 30 - 60 min	100mL	G or N (minibag plus)	
Gentamicin	For dosing and monitoring guidance please refer to the Trust intranet gentamicin or the Microguide App				

	Once daily regimen	IV infusion over 60 min	100mL	G or N	
Drug	Standard IV Dose (normal renal function)	Route and Directions	Reconstitution	Diluent	Notes
Meropenem	1-2g 8h	IV bolus over 5 mins	1g each 20mL	WFI	In organisms with a high MIC, 2g infusions given over 3 hours every 8 hours may be more appropriate
		IV Infusion	100mL	G or N	
Piperacillin with tazobactam (Tazocin®)	4.5g 6-8h	IV bolus (unlicensed)	20mL	WFI or N	1. Penicillin; In organisms with a high MIC, infusions given over 3 hours every 8 hours may be more appropriate 2. IV bolus if fluid restricted. Tazocin® has a high osmolarity and may cause venous irritation and tissue damage in cases of extravasation.
		IV infusion	50mL	G or N	
Vancomycin	See separate protocol on page 46				

Antifungals

Amphotericin (<i>AmBisome</i> ®)	1mg over 10 minutes (test dose) then <u>3mg/kg daily</u> ; max. 5mg/kg daily (unlicensed)	IV infusion over 60 min	Reconstitute each vial with 12 mL of WFI (4mg/mL) and shake vigorously. Withdraw the required dose and add to diluent through the 5 micron filter provided (to make a final volume of 250mL)	G	1. Dilute to a maximum conc. of 2mg/ml if patient fluid restricted
Caspofungin	70mg initial dose Then either 70mg daily (in patients >80Kg)		1) Bring vial to room temp 2) Reconstitute each vial with 10.5mL of WFI	N	1. 50mg can be made up to 100mL if necessary (e.g. fluid restricted)

	Or 50mg daily (in patients <80Kg)	IV infusion over 60 min	3) Mix gently 4) Withdraw 10mL 5) Make up to 250mL		
Drug	Standard IV Dose (normal renal function)	Route and Directions	Reconstitution	Diluent	Notes
Voriconazole	6mg/kg 12h for two doses then 4mg/kg 12h	IV infusion: rate not exceeding 3mg/kg/hour	Reconstitute each 200mg with 19mL WFI to produce 10mg/mL soln; dilute dose in infusion fluid to conc of 0.5-5mg/mL	G or N	
Antivirals					
Aciclovir	5mg/kg 8h doubled to 10mg/kg 8h in immunocompromised patients with varicella-zoster and patients with simplex encephalitis. - Prophylactic dose 5mg/kg 8h - Use ideal body weight if obese	IV infusion over 1hour	Dilute to 5mg/mL with G or N. For example: doses of 500mg or less to 100mL. Doses greater than 500mg dilute to 250mL.	0.9% NaCl	

INTRODUCTION

Vancomycin (a glycopeptide antibiotic) exhibits time-dependant bacterial killing, so its efficacy is dictated by the amount of time its levels are above the minimum inhibitory concentration (MIC). High peaks are not associated with improved bactericidal effects and may be associated with increased toxicity. Administration of vancomycin by continuous infusion ensures high peaks are avoided, but adequate levels above the MIC are maintained at all times.

LOADING DOSE

All patients should receive a weight-related **loading dose**.

< 70 kg	1000 mg IV in 250 ml 0.9% sodium chloride or 5% glucose over 100mins
70 – 90 kg	1500 mg IV in 250 ml 0.9% sodium chloride or 5% glucose over 150mins
> 90 kg	2000 mg IV in 250 ml 0.9% sodium chloride or 5% glucose over 200mins

Central administration: the final concentration should not exceed 10mg/ml (i.e. 2500mg/250ml).

Peripheral administration: the final concentration should not exceed 5mg/ml (i.e. 1250mg/250ml).

MAINTENANCE INFUSION

Start the maintenance intravenous infusion immediately after the loading dose. The dose depends on the patient's renal function. **Infusions should be administered in 250 ml 0.9% sodium chloride or 5% Glucose over 12 hours. The total daily dose should be split into two and the infusion rate set at 20.8 ml/hr.**

Creatinine clearance (CrCl) (ml/min) – see below	Total daily dose	Dose in each 250 ml infusion bag for administration over 12 hours.
<20	500 mg	250 mg
20-34 or CVVHD	750 mg	375 mg
35-59	1000 mg	500 mg
60-79	1500 mg	750 mg
80-99	2000 mg	1000 mg
>100	2500 mg	1250 mg

Cockcroft and Gault equation:

$$\text{CrCl (ml/min)} = \frac{(140 - \text{age}) \times \text{wt(kg)}}{\text{Serum creatinine (micromol/l)}} \times [1.23(\text{male}) \text{ or } 1.04(\text{female})]$$

If the patient is obese then use ideal bodyweight:

IBW (kg)

Males 50kg +2.3kg for every inch over 5 feet

Females 45.5kg +2.3kg for every inch over 5 feet

DOSE ADJUSTMENT

Request a serum level with morning bloods daily (alternate days if 2 consecutive levels within range and renal function stable), or as advised by the pharmacist. On week days, the critical care pharmacist will advise on dosage adjustments. Out of hours or at weekends, please use the following guidelines after at least 24 hours of treatment have been administered.

Vancomycin conc.	Suggested dosage change
< 15 mg/L	Increase the daily dose by 500 mg
15 – 25 mg/L	No change
> 25 mg/L	Decrease the daily dose by 500 mg*
> 30 mg/L	Stop infusion and reanalyse the next morning. Restart at a lower dose (no loading required).

*If the patient is only receiving 500 mg /day, reduce the dose to 250 mg /day

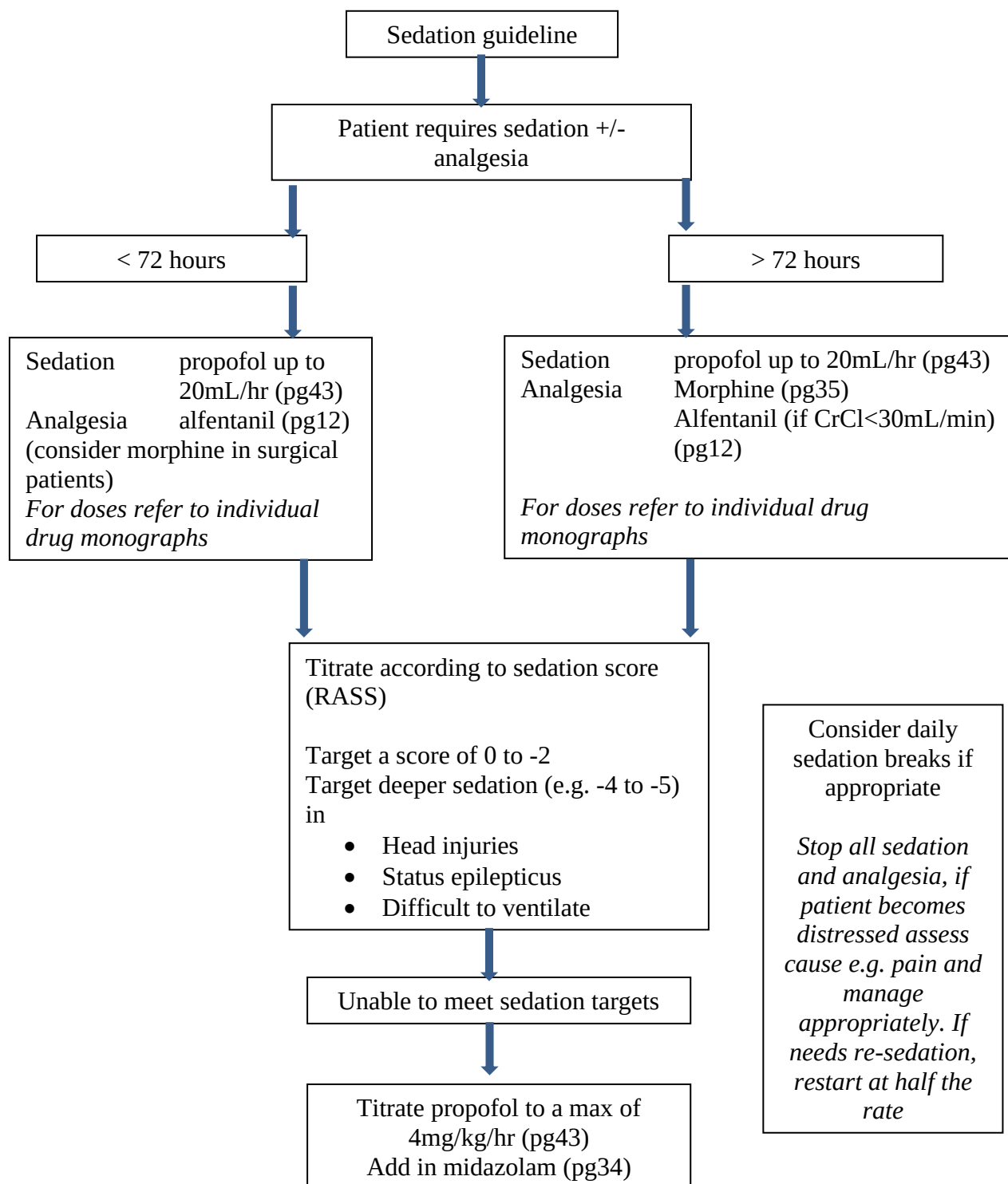
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Sedation guideline

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Weaning sedation with the aim to extubation

- Reduce/Stop all sedatives/analgesics and assess patient once awake
- On-going analgesia needs should be taken into account
- In complex patients e.g. sedated >72 hours or distressed/delirious on waking consider
 - Remifentanyl (pg56)
 - Clonidine (pg22)
 - Dexmedetomidine (pg24)

Remember clonidine may take up to 48 hours to be maximally effective

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VTE prophylaxis in critical care

VTE prophylaxis in the critical care setting

Choice of therapy

Enoxaparin (unless contraindicated e.g. heparin induced thrombocytopenia (HIT), hyperkalaemia secondary to LMWH)

- If patient has HIT or LMWH induced hyperkalaemia, **Danaparoid** is drug of choice.
- If patient is thrombocytopenic with a platelet count $< 75 \times 10^9/L$ for any reason other than HIT e.g. sepsis then consider omitting prophylactic drug therapy
- For patients receiving renal replacement therapies continue prophylaxis if prescribed and not contra-indicated e.g. Major bleeding
- See **Notes** for guidance on dosing and surgical procedures

Dose

Enoxaparin for VTE prophylaxis

- If CrCl $> 30\text{mL/min}$, 40mg s/c once daily (generally prescribed at 6pm)
- If CrCl $15 - 30\text{mL/min}$, 20mg s/c once daily
- If CrCl $< 15\text{mL/min}$, manufacturer states contraindicated, use 20mg s/c once daily if benefit outweighs risk

(work out CrCl using Cockcroft and Gault, see guidance on page 3)

Danaparoid

1) In patients with HIT

- If patient diagnosed with HIT they require full (not prophylactic) anticoagulation
- Loading dose weight dependent

Patient weight	Bolus loading dose	Volume of <u>undiluted</u> drug (750units/0.6mL)
less than 55kg	1250 units	1mL
55 – 90kg	2500 units	2mL
over 90kg	3750 units	3mL

- followed by an intravenous infusion of diluted drug (4,500units/45mL, see below) at 400units/hr (4mL/hr) for 2 hours, then 300 units/hr (3mL/hr) for 2 hours, then a maintenance infusion of 200 units/hr (2mL/hr)

2) Prophylaxis if e.g. LMWH induced hyperkalaemia

- 750 units (0.6mL) s/c bd

Reconstitution (Danaparoid infusion)

For continuous infusion of danaparoid, reconstitute 6 x 750unit/0.6mL ampoules to 45mL with 0.9% NaCl or glucose 5% (final concentration 4,500units/45mL)

Notes

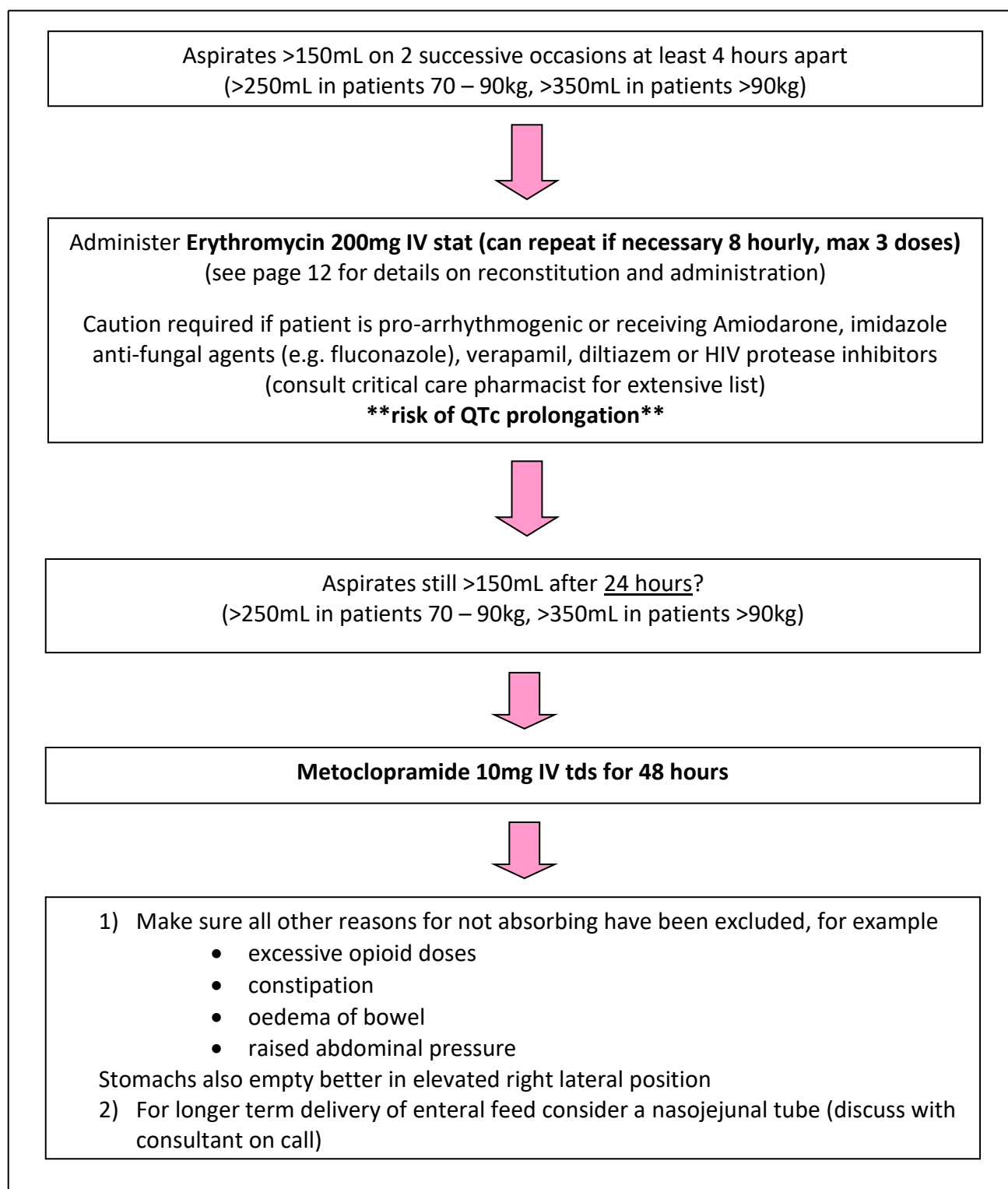
1. Enoxaparin can be partially neutralised (maximum about 60%) with protamine - 1mg of protamine should be given for every 1mg of enoxaparin (Refer to SPC for more detailed information)
2. Placement or removal of an epidural catheter should be delayed for 10 - 12 hours after administration of DVT prophylactic doses of enoxaparin, whereas patients receiving higher doses of enoxaparin sodium (1.5 mg/kg once daily) will require longer delays (24 hours). The subsequent enoxaparin sodium dose should be given no sooner than 4 hours after catheter removal. The same guidance applies to any other surgical procedure where possible e.g. the forming of a tracheostomy.

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Prokinetics

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Prokinetic prescribing flow chart



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