Critical Care infusions guideline-Adults

Scope:
The purpose of this guideline is to outline the locally approved dilutions, administration rates and doses of various ICU specific infusions. It will also give brief guidance on key clinical factors in decision to use a particular drug and key risks and issues to be aware of, as well as brief pharmacological background. It is *not* intended to be an extensive educational piece on how to use these drugs but rather an aide memoir to experienced clinicians familiar with their general principles.

This guideline covers the use of these infusions on critical care. It is designed for use in adult patients only. For paediatric patients use PICU specialist resources.

Contents of this guideline:

Format:
This guideline is formatted as a collection of monographs with an overview on the front page and pharmacology and warnings on the back-page. In addition, the back-page contains useful Y-site compatibility for anaesthetic agents. Laminated copies of these monographs are available at the nurse's station on each side for reference.

Metaraminol	**Peripheral administration**

Core Information

Drug name:	Metaraminol
Alternate names:	None
Presentation:	10mg in 1ml ampoules 2.5mg in 5ml pre-filled syringe (for bolus doses only)
Indications:	Post-operative hypotension Epidural related hypotension Mild shock states not requiring high doses of vasopressor support where patient does not have a central line
Storage:	Room temperature
Route:	May be given peripherally or centrally. If peripheral administration, ensure large peripheral vein.
Dilution Instructions	Draw up 57ml of 0.9% NaCl into a syringe Add 3ml (30mg) of metaraminol solution Final concentration=0.5mg/ml
Usual dosage range	0.5-5mg/hr (1-10ml/hr)
Titration advice:	Increase/decrease infusion by 1-3ml/hr every 10-15minutes to target MAP

Drug properties	
Clinical pharmacology	Metaraminol is a vasopressor drug which works principally via α_1-receptors. It has direct receptor agonist activity and indirect activity via displacing endogenous noradrenaline into the synapse. Principal effects are an increase in systemic and pulmonary vascular resistance, an increase in MAP and coronary blood flow. Commonly metaraminol causes reflex bradycardia and reduced cardiac output. Decreased blood flow to kidneys may also occur. Tachyphylaxis to the drug may occur more commonly than with noradrenaline after prolonged infusion.
Onset and duration of effect	Onset: 2minutes Duration: 20-60 minutes
Side-effects	Bradycardia, peripheral necrosis upon extravasation hypertension, headache, arrhythmias
Cautions	Peripheral vascular disease, cirrhosis (effect may be prolonged), diabetes, elderly patients, immediate aftermath of an MI, hyperthyroidism, uncorrected hypovolaemia, Prinzmetal's angina.
Contraindications	Hypertension.
Y-site compatible drugs and infusions	Glucose 5% and sodium chloride 0.9%.
Y-site incompatible drugs and infusions	Amphotericin B, benzylpenicillin, dexamethasone, erythromycin, hydrocortisone, thiopentone.

Noradrenaline	**CVC ONLY-DO NOT BOLUS**

Core Information

Drug name:	Noradrenaline
Alternate names:	Noradrenaline acid tartrate (salt form) Norepinephrine (US)
Presentation:	8mg in 50ml ready-to-administer bottles or 4mg/4ml ampoules
Indications:	Restoring and maintaining BP in acute hypotension 1st line vasopressor for septic shock
Storage:	Room temperature
Route:	Central venous route ONLY (for peripheral admin guidance see peripheral pressors guideline)
Dilution Instructions	1st line: Use ready-to-administer bottles-spike and hang (Strength 160 microgram/ml) **Large Bag (for patients on high infusion rates):** Remove 40ml from a 250ml bag of 5% glucose Add 40ml (40mg) of norad. Final concentration 160microgram/ml
Usual dosage range **In obesity use ideal body weight**	0.01-1 microgram/kg/min
Titration advice	Rapid effect. Adjust dose in 0.05-0.1µg/kg/min increments every 30s-1minute to achieve target MAP or as directed by consultant

Drug properties	
Clinical pharmacology	Noradrenaline is a catecholamine, meaning it is a natural hormone & neurotransmitter, derived from tyrosine, produced by both adrenal glands and sympathetic neurones in the body. Noradrenaline acid tartrate is the synthetic version. It is predominantly a vasopressor with mild inotropic effect (inopressor) acting predominantly on α_1 receptors with some effect on β_1 receptors. It increases peripheral vascular resistance increasing systolic and diastolic blood pressure increases with generally a net neutral effect on cardiac output.
Onset and duration of effect	Peak effect within 1-2 mins of starting infusion Very short duration of action (1-2mins) due to incredibly short half-life.
Side-effects	Arrhythmias Tissue ischaemia & peripheral necrosis Hypertension Bradycardia
Cautions	Caution in patients with low circulatory volume Peripheral vascular disease.
Contraindications	Hypertension
Y-site compatible drugs and infusions	Catecholamine vasopressors are in general given via a dedicated line and not co-infused. Subtle alterations in flow via concomitant Y-site infusion may disturb precise delivered dose of pressor which may have adverse effects. Occasionally co-infusion of two pressors together in extremis may be warranted-this should be discussed with NIC or consultant
Y-site incompatible drugs and infusions	All - as above

Phenylephrine	**Central or peripheral**

Core Information

Drug name:	Phenylephrine
Alternate names:	None
Presentation:	10mg/ml, 1ml ampoules
Indications:	Acute hypotension In patients without central access in whom mild vasopressor effect is desired Epidural-related hypotension Used in cases of metaraminol shortage
Storage:	Room temp
Route:	Central or large peripheral line
Dilution Instructions	Remove 5ml from a 500ml bag of 5% glucose. Add 5ml (50mg) of phenylephrine Final concentration=0.1mg/ml
Usual dosage range	0.5-5mg/hr (5-50ml/hr)
Titration advice	Adjust in 0.5mg/hr (5ml/hr) increments every 5 minutes titrating to target MAP

Drug properties	
Clinical pharmacology	Phenylephrine is a vasopressor which binds to α_1 receptors causing vasoconstriction, increasing systemic vascular resistance. Unlike noradrenaline it does not have an effect on β-receptors, nor does it displace neurotransmitter like metaraminol; it is a pure alpha agonist. It is 13x less potent than noradrenaline so can be safely given peripherally. It does stimulate the baroreceptor reflex, thus precipitating bradycardia. It is useful as a potential replacement to metaraminol in times of stock shortage.
Onset and duration of effect	Onset: 2minutes Duration: ~20 minutes
Side-effects	Bradycardia, tachycardia, hypertension, arrythmias, peripheral ischaemia upon extravasation
Cautions	Patients with severe ischaemic heart disease, diabetes (may precipitate hyperglycaemia), uncontrolled glaucoma, hyperthyroidism
Contraindications	Severe uncontrolled hypertension.
Y-site compatible drugs and infusions	**ICU infusions**: Cisatracurium, dexmedetomidine **Other drugs**: Amiodarone, argatroban (in 0.9% NaCl), anidulafungin (in 5% glucose), bivalirudin, caspofungin, levofloxacin (glucose 5%), micafungin (in 0.9% NaCl), zidovudine (in 5% glucose) **Fluid infusions**: 0.9% NaCl, 5% glucose
Y-site incompatible drugs and infusions	Iron salts, phenytoin, furosemide

Vasopressin	**CVC ONLY**

Core Information

Drug name:	Vasopressin,
Alternate names:	Argipressin™, Arginine vasopressin
Presentation:	20units in 1ml vials
Indications:	Hypotension in septic shock
Storage:	Store in a refrigerator between 2-8°C
Route:	Continuous infusion via central line only
Dilution Instructions:	Draw 1ml (20 units) of vasopressin. Add to 49ml 5% glucose to give final volume of 50ml (0.4 units/ml)
Usual dosage range:	0.6units/hr to 2.4 units/hr 2.4-3.6 units/hr if sanctioned by critical care consultant. Avoid doses >3.6 units/hr (significant increase in cardiac ischaemia)
Titration advice	Start at 0.6-1.2 units/hr depending on severity of shock Adjust in increments of 0.6 units/hr every 30 minutes titrating to target MAP

Drug properties	
Clinical pharmacology	Arginine vasopressin is a synthetic version of natural anti-diuretic hormone (ADH) that leads to increase in blood pressure and renal retention of water. It induces effects through several receptors. V1 on vascular smooth muscle is responsible for vasoconstriction by increasing intracellular calcium concentration. Activation of V2 receptors on renal tubules is responsible for water resorption. V3 pituitary receptors have central effects such as increasing adrenocorticotrophic hormone production. In severe sepsis there is thought to be a relative deficiency of endogenous ADH which can lead to relative resistance to noradrenaline, restored by infusion of vasopressin. It may cause some pulmonary vasodilation which can be helpful in the context of pulmonary hypertension.
Onset and duration of effect	Plasma half-life of about 10-20minutes, therefore requires a slower titration approach than noradrenaline.
Side-effects	Fluid retention, pallor, tremor, sweating, hypersensitivity reactions, nausea, vomiting, abdominal cramps. Constriction of coronary arteries, peripheral ischaemia and rarely gangrene.
Cautions	History of mesenteric ischaemia. Vascular disease (especially of coronary arteries); monitor with extreme caution. Monitor extremities for changes in colour and skin temperature
Contraindications	Known hypersensitivity reactions to product or excipients.
Y-site compatible drugs and infusions	Catecholamine vasopressors are in general given via a dedicated line and not co-infused. Subtle alterations in flow via concomitant Y-site infusion may disturb precise delivered dose of pressor which may have adverse effects. Occasionally co-infusion of two pressors together in extremis may be warranted-this should be discussed with NIC or consultant
Y-site incompatible drugs and infusions	All - as above.

Adrenaline	**This protocol is for central infusion only**

Core Information

Drug name:	Adrenaline
Alternate names:	Epinephrine
Presentation:	1 in 1000, 1ml amps [1mg/ml]
Indications:	Restoration and maintenance of BP in acute hypotension refractory to 1st line therapies. Cardiac arrest and low cardiac output states. Anaphylaxis
Storage:	Room temperature
Route:	Central venous route ONLY (for peripheral admin see peripheral vasopressors guideline)
Dilution Instructions	**Standard:** Remove 8ml from a 100ml bag 5% glucose Add 8mg (8ml) of adrenaline *1 in 1000* concentrate [CAUTION-CHECK STRENGTH CAREFULLY] Final concentration= 80 microgram/ml **Large bag:** Remove 20ml from a 250ml bag glucose 5% Add 20mg (20ml) of adrenaline 1 in 1000 concentrate. Final concentration= 80 microgram/ml
Usual dosage range **In obesity use ideal body weight**	0.01-0.2 micrograms/kg/min (In severe shock doses may exceed this significantly)
Titration advice	Rapid effect. Adjust dose in 0.05-0.1µg/kg/min increments every 30s-1minute to achieve target MAP or as directed by consultant

Drug properties	
Clinical pharmacology	Adrenaline is a catecholamine hormone, produced by the adrenal glands in response to stress. It acts on all adrenoceptors in the body (principally α_1, β_1 and β_2). In lower doses (0.04-0.1µg/kg/min) the beta-effects are dominant rendering it an inotrope (increasing cardiac output) and a chronotrope (increasing heart rate). As the infusion is increased through the dose range the alpha effects increase and it has more powerful vasopressor action causing vasoconstriction and increasing systemic vascular resistance. Via action on β_2 receptors, adrenaline upregulates glycolysis, driving up serum lactate levels (Type B lactataemia). It also has a bronchodilatory effect in the lungs.
Onset and duration of effect	Peak onset of effect: 1-2 mins Duration of action: 1-2 mins following infusion discontinuation due to short half-life.
Side-effects	Tachycardia, myocardial ischaemia (increases cardiac oxygen demand), arrhythmias, peripheral ischaemia, metabolic disturbances including hyperglycaemia, hypokalaemia and elevated serum lactate levels. Tremor and rigidity reported in those with Parkinsonian syndromes.
Cautions	Uncorrected hypovolaemia, peripheral vascular disease, ischaemic heart disease, phaeochromocytoma. Product contains sodium metabisulfite which may cause hypersensitivity reactions in certain individuals
Contraindications	Hypertension as a relative contraindication
Y-site compatible drugs and infusions	Catecholamine vasopressors are in general given via a dedicated line and not co-infused. Subtle alterations in flow via concomitant Y-site infusion may disturb precise delivered dose of pressor which may have adverse effects. Occasionally co-infusion of two pressors together in extremis may be warranted-this should be discussed with NIC or consultant
Y-site incompatible drugs and infusions	All - as above

Dobutamine

Central or peripheral-DO NOT BOLUS

Core Information

Drug name:	Dobutamine
Alternate names:	None
Presentation:	250mg in 20ml vials 250mg in 50ml ready to administer bottles
Indications:	To improve cardiac output in low output states: e.g. post-MI, cardiomyopathy, septic shock, cardiogenic shock
Storage:	Room temperature
Route:	Central 1st line due to low pH May be given via large peripheral line if necessary
Dilution Instructions	Remove 40ml from a 100ml bag of 5% glucose Add 40ml (500mg) to the bag Final concentration=5mg/ml
Usual dosage range **In obesity use ideal body weight**	2.5-20mcg/kg/min
Titration advice	Usually start at 2.5mcg/kg/min Increase in increments of 1-2.5mcg/kg/min as directed by clinicians or minimum every 5mins if titrating directly against a CV target (medical team to advise) Tachycardia may limit titration-discuss with doctors

Drug properties	
Clinical pharmacology	Dobutamine is an inotrope with modest vasodilatory properties (inodilator). It predominantly acts on β_1 receptors producing a dose dependent increase in cardiac output. It is also a modest chronotrope; tachycardia may become problematic with higher doses. It has some effect on β_2 receptors producing vasodilation and mild decreases in systemic vascular resistance. In acute heart failure this may be beneficial by reducing afterload. On the other hand in vasodilated shock states such as sepsis decrease in MAP due to worsening vasodilation may occur. Because of this it may be necessary to co-administer with a vasopressor such as noradrenaline.
Onset and duration of effect	Onset 1-2 mins Duration 1-2mins
Side-effects	Increases myocardial oxygen demand, which may lead to cardiac ischaemia. Can precipitate cardiac arrhythmias, hypertension, hypotension, reduced platelet aggregation (on prolonged use), tachycardia.
Cautions	Patients at risk of arrhythmias, hyperthyroidism, ischaemic heart disease, obstruction of ejection, occlusive vascular disease, severe hypotension. Although can be given peripherally may still cause tissue injury if extravasates-monitor site.
Contraindications	Severe obstruction of cardiac ejection (e.g. hypertrophic sub-aortic stenosis), phaeochromocytoma
Y-site compatible drugs and infusions	Catecholamine vasopressors are in general given via a dedicated line and not co-infused. Subtle alterations in flow via concomitant Y-site infusion may disturb precise delivered dose of pressor which may have adverse effects. Occasionally co-infusion of two pressors together in extremis may be warranted-this should be discussed with NIC or consultant
Y-site incompatible drugs and infusions	All - as above

Dopamine	**CENTRAL line-4mg/ml dilution [ICU only]** **Large peripheral 2nd line for 1.6mg/ml**

Core Information

Drug name:	Dopamine
Alternate names:	None
Presentation:	200mg in 5ml amps 400mg in 250ml 5% glucose pre-mixed bag
Indications:	Acute hypotension or shock associated with MI, sepsis or trauma Chronic cardiac decompensation in congestive cardiac failure
Storage:	Room temp
Route:	Central route is 1st line for all indications 1.6mg/ml dilution may be given via large peripheral cannula with caution
Dilution Instructions	**Cath labs/Coronary care unit:** Use premixed bag OR remove 10ml from 250ml bag of 5% glucose, Add 10ml (400mg) of dopamine. Final concentration=1.6mg/ml **Critical care only:** Remove 10ml from a 100ml bag of 5% glucose Add 10ml (400mg) of dopamine Final concentration=4mg/ml
Usual dosage range **In obesity use ideal body weight**	Start at 2.5µg/kg/min Titrate in 5-10µg/kg/min increments every 10-30 mins Usual range 5-20µg/kg/min
Titration advice	Start at 2.5µg/kg/min. Titrate in 1-5µg/kg/min increments every 5 mins titrating against a CV parameter or as directed by clinicians

Drug properties	
Clinical pharmacology	Dopamine is a natural catecholamine hormone/neurotransmitter. It has an interesting dose dependent pharmacology. Low doses (0.5-2.5µg/kg/min) act on dopamine receptors which causes vasodilation in the splanchic, coronary and renal vascular beds, promoting a temporary increase in renal perfusion and urine output. Medium doses (5-10µg/kg/min) act on β_1 receptors to increase heart rate and force of contraction (inotropy) and high doses >10µg/kg/min increasingly act on α_1 receptors promoting vasoconstriction (vasopressor effect).
Onset and duration of effect	Onset within 5 mins Duration <10 mins
Side-effects	Nausea, vomiting, peripheral vasoconstriction, anginal pain, dyspnoea, tachycardia and arrhythmias. Extravasation injury can be severe if given peripherally.
Cautions	Caution in peripheral vascular disease; monitor for reduced digital perfusion and necrosis Ensure adequate volume loading to avoid tachycardia and hypotension Caution in patients on MAOIs-reduce starting dose to 10% of usual dose. Phenytoin may cause hypotension & bradycardia in combination. Concomitant ergot alkaloids and tricyclic antidepressants should be avoided.
Contraindications	Avoid in phaeochromocytoma, uncorrected tachyarrhythmias, ventricular fibrillation or untreated hyperthyroidism.
Y-site compatible drugs and infusions	Catecholamine vasopressors are in general given via a dedicated line and not co-infused. Subtle alterations in flow via concomitant Y-site infusion may disturb precise delivered dose of pressor which may have adverse effects. Occasionally co-infusion of two pressors together in extremis may be warranted-this should be discussed with NIC or consultant
Y-site incompatible drugs and infusions	All - as above

Isoprenaline	Central or peripheral

Core Information

Drug name:	Isoprenaline Available as hydrochloride and sulfate salts
Alternate names:	None
Presentation:	2mg in 2ml ampoules (unlicensed), 1mg in 5ml ampoules (licensed)
Indications:	Heart block, temporary control of severe bradycardia that is unresponsive to atropine
Storage:	Store vials at 2°C-8°C (in fridge)
Route:	1st line: central, if central access not available then 2nd line: via a large peripheral vein with extravasation monitoring.
Dilution Instructions	**Peripheral administration:** Dilute 2mg with glucose 5% to 100ml to give a concentration of 20micrograms/1ml. **Central administration:** dilute 4mg with glucose 5% to 50ml to give a concentration of 80microgram/1ml.
Usual dosage range	0.1-15micrograms/min
Titration advice	Usually start at 1microgram/min Titrate in 1microgram/min intervals every 2-3mins until target HR achieved [Hypotension/arrythmias may limit titration]

Drug properties	
Clinical pharmacology	Isoprenaline stimulates both β1 and β2 adrenoceptors producing an increase in cardiac output by increasing both myocardial contractility and heart rate.
Onset and duration of effect	Half-life of about one to several minutes
Side-effects	Tachycardia, arrhythmia, precordial pain, low blood pressure, high blood pressure, nervousness, shakiness, dizziness, headache, nausea and asthenia.
Cautions	Diabetes, digitalis poisoning, hyperthyroidism, cardiovascular disorders especially coronary insufficiency, arrhythmias and hypertension. Caution in convulsive disorders,
Contraindications	Hypersensitivity to isoprenaline, concomitant use with adrenaline, pre-existing ventricular arrythmias, tachyarrhythmias, cardiac glycoside intoxication, myocardial infarction, angina pectoris.
Y-site compatible drugs and infusions	Catecholamine vasopressors are in general given via a dedicated line and not co-infused. Subtle alterations in flow via concomitant Y-site infusion may disturb precise delivered dose of pressor which may have adverse effects. Occasionally co-infusion of two pressors together in extremis may be warranted-this should be discussed with NIC or consultant
Y-site incompatible drugs and infusions	All – as above

Switching between salt forms

Isoprenaline is available in two formulations: isoprenaline hydrochloride and isoprenaline sulfate. These salt forms are NOT equivalent and have different potencies:

Isoprenaline hydrochloride 2mg ≡ Isoprenaline sulfate 2.25mg

In practice this is a titrate-to-effect drug and is only relevant if you need to change salt forms partway through an infusion (e.g. due to stock availability). In this instance either

1) Increase infusion rate by 10% when switching from hydrochloride to sulfate salt, decrease infusion rate by 10% when switching from sulfate to hydrochloride salt
   OR
2) Maintain same infusion rate, anticipate altered effect, monitor and adjust rate based on observed change in chronotropy when switching product.

Levosimendan	**Central or peripheral**

Core Information

Drug name:	Levosimendan
Alternate names:	N/A
Presentation:	12.5mg/5ml vials
Indications:	Acute decompensated severe chronic heart failure, left ventricular failure post MI, low cardiac output syndrome or cardiogenic shock, treatment of undesirable adverse effects of dobutamine. Should have demonstrable failure to respond to milrinone (1st line) before consideration.
Storage:	Store vials at 2°C-8°C (in fridge)
Route:	Peripheral or central line
Dilution Instructions	Dilute ONE 5ml vial to 250ml with glucose 5% to produce a final concentration of 0.05mg/ml. Expiry time to write on label: 24 hours
Usual dosage range In obesity use ideal body weight	No loading dose required. Initial rate = 0.1microgram/kg/min and if tolerated can increase to 0.2micrograms/kg/min after 4 hours. **Infuse for 24hrs or until the contents of one vial has been administered then stop. Rarely, if patient on 0.2mcg/kg/hr, can start a 2nd vial to ensure ~24hrs of infusion has been given.**
Titration advice	Usually, unnecessary. Start at 0.1mcg/kg/min. Reduce dose only if dictated by unacceptable hypotension/tachycardia. Only increase to 0.2mcg/kg/min if directed by consultant if increased haemodynamic effect desired.

Drug properties	
Clinical pharmacology	Levosimendan is a positive inotrope that acts as a calcium sensitiser that (i) increases the sensitivity of cardiomyocyte to intracellular calcium by binding to troponin C; (ii) causes vasodilatation by opening ATP dependent potassium channels on vasculature smooth muscle cells; and (iii) cardio-protects by opening mitochondrial potassium channels in the cardiomyocytes. Levosimendan decreases pulmonary capillary wedge pressure and pulmonary artery pressure. Due to its vasodilatory nature, it reduces preload and afterload. Short term use of levosimendan causes rapid dose-dependent improvement in haemodynamics and symptoms in patients with decompensated heart failure.
Onset and duration of effect	Half-life of about 1 hour; metabolised to an active metabolite (ORG 1896) which has a half-life of 80hrs. Haemodynamic effects of levosimendan persist for up to 9 days after stopping a 24hr infusion.
Side-effects	Hypokalaemia, insomnia, headache, dizziness, ventricular tachycardia, atrial fibrillation, tachycardia, ventricular extrasystoles, cardiac failure, myocardial ischaemia, extrasystoles
Cautions	Renal impairment, hepatic impairment, use with caution in patients with low baseline systolic or diastolic blood pressure, severe hypovolaemia should be corrected prior to levosimendan infusion, low potassium should be corrected prior to levosimendan infusion, patients with concurrent anaemia, patients with tachycardia atrial fibrillation with ventricular response or potentially life threatening arrythmias. Extravasation is likely to cause tissue damage as levosimendan has a low pH
Contraindications	Right heart failure, high output failure, significant mechanical obstruction, congenital heart disease, isolated diastolic dysfunction, hypertrophic cardiomyopathy, uncorrected stenotic valve disease, endocarditis, un-correctable medical condition/prior cardiac arrest without demonstrable neurological recovery, severe hypotension and tachycardia, severe renal impairment, severe hepatic impairment, history of torsades de pointes, hypersensitivity to levosimendan.
Y-site compatible drugs and infusions	Furosemide, digoxin, glucose 5%, glyceryl trinitrate
Y-site incompatible drugs and infusions	No specific information

Milrinone	**Central (1st line) or peripheral**

Core Information

Drug name:	Milrinone
Alternate names:	None
Presentation:	1mg/ml, 10ml amps
Indications:	Severe congestive heart failure, refractory to standard maintenance therapies Cardiogenic shock Acute heart failure with low output states
Storage:	Room temperature
Route:	Central (preferably due to risk of extravasation injury)-peripheral if necessary
Dilution Instructions	Draw up 10ml of milrinone solution (10mg) Make up to final volume of 50ml with 40ml of 5% glucose Final concentration 200micrograms/ml
Usual dosage range **In obesity use ideal body weight**	**Maintenance infusion:** 0.2-0.75 microgram/kg/min **Dosing in renal failure:** Titrate to effect but allow longer between dose changes to reach steady state. **Avoid loading doses in critically ill patients due to risk of severe hypotension**
Titration advice	Start at 0.2mcg/kg/min. Adjust dose every 2-4hrs (4hrly in severe renal failure) in increments of 0.125mcg/kg/min. Titrate to parameter set by medical team In patients stabilised on a dose where new renal failure occurs anticipate potential need to reduce dose if increasing hypotension occurs. If severe hypotension ensues consider reducing to lowest possible dose to allow arterial BP to recover.

Drug properties	
Clinical pharmacology	Milrinone is a type 3 phosphodiesterase inhibitor which exerts an inotropic effect on the heart and a vasodilatory effect on blood vessels. Milrinone may have advantages over dobutamine as an inotrope in patients with tachycardia or those with chronic heart failure on β-blockers in whom beta-adrenoceptors can become down-regulated. It may also offer additional support in right ventricular failure due to its pulmonary vasodilator effects. Milrinone may produce a slight enhancement in AV conduction which may possibly increase ventricular response in uncontrolled AF/flutter.
Onset and duration of effect	Onset of effect within 15-15mins Duration of action: 3-5hrs
Side-effects	Common: Headache, ventricular ectopics & tachycardia, arrhythmias, hypotension Uncommon: thrombocytopenia, hypokalaemia, tremor, VF, angina, abnormal LFTs Very rare: Torsades des pointes, bronchospasm, skin reactions, anaphylaxis
Cautions	Caution in the immediate aftermath of an MI or in aortic or pulmonary valvular disease or stenosis. Caution in those at risk of arrhythmias (ensure correction of potassium & magnesium). Caution in AF (see above-consider digitalisation) and in those on diuretics or with concomitant vasoplegia (may need to increase pressor dose). **Renal failure:** Accumulates in renal failure. Titrate to effect as normal but allow longer (minimum 4hrs) between dose adjustments to reach steady state before further altering dose.
Contraindications	Severe hypovolaemia (correct first), hypersensitivity to milrinone. Do not exceed 1.13mg/kg per 24hrs. Do not use in left ventricular outflow tract obstruction.
Y-site compatible drugs and infusions	**ICU infusions:** Atracurium, clonidine, dexmedetomidine, morphine, midazolam, propofol **Other drugs:** Amiodarone, heparin, insulin, lorazepam, potassium, Tazocin, vancomycin **Fluid infusions:** Sodium chloride 0.9%, Hartmann's solution, glucose 5 & 10%, glucose-sodium chloride This list is not exhaustive, see Medusa online for full list.
Y-site incompatible drugs and infusions	Furosemide, imipenem with cilastin

AMIODARONE	CVC (1st Line), Peripheral (2nd line)

Core Information

Drug name:	Amiodarone
Alternate names:	N/A
Presentation:	150mg/3ml concentrate for injection ampoules
Indications:	Treatment of tachyarrhythmias
Storage:	Room temperature
Route:	Central administration via CVC (1st line) May be given via peripheral line for up to 24hrs (500ml dilution only) (2nd line)
Dilution Instructions	**Loading dose:** 300mg should be diluted in 250ml glucose 5% **Maintenance infusion:** *Standard:* Dilute 900mg (18ml) with 482ml glucose 5% *Concentrate (fluid restriction)-CVC ONLY:* Dilute 900mg (18ml) with 32ml 5% glucose **Do not prepare in sodium chloride.**
Usual dosage range	**Loading dose:** 300mg given over 1hr **Maintenance infusion:** 900mg bag given at a rate of 21ml/hr (standard strength) or 2.1ml/hr concentrated form. Subsequent doses of 600-900mg/day given until cardiac stability achieved (600mg for lower weight patients)

Drug properties	
Clinical pharmacology	Amiodarone is an anti-arrhythmic drug which works to suppress tachyarrhythmias by potassium channel blockade, sodium channel blockade and calcium channel blockade. This significantly prolongs the action potential and repolarisation phase and decreases AV nodal conduction.
Onset and duration of effect	Unlike oral amiodarone which takes between 2 days to 3 weeks to begin working IV amiodarone has an onset of within 1 hr following IV loading. Short durations of IV therapy have correspondingly short durations of action (plasma level falls to sub-therapeutic concentration within 4 hrs of discontinuation. Once a patient has been fully loaded (approximately 5-6 days of continuous IV infusion) half-life of drug can exceed 50 days.
Side-effects	With IV infusion: bradycardia, nausea and vomiting, cardiac arrhythmias (may cause as well as treat), asystole, heart failure and hypotension. Acute respiratory distress syndrome is a rare complication. Many of the short-term adverse effects of amiodarone are due to the polysorbate 80 (Tween 80) or benzyl alcohol present in the formulation rather than the drug itself.
Cautions	Heart failure, hypokalaemia (increased risk of Torsades des pointes), severe bradycardia, circulatory collapse, severe pre-existing liver damage, hypothyroidism
Contraindications	Severe conduction disturbances, sinus bradycardia, hyperthyroidism, uncontrolled severe hypotension, avoid bolus injection in cardiomyopathy and congestive cardiac failure. Not appropriate for Torsades des pointes.
Y-site compatible drugs and infusions	**ICU infusions:** atracurium, atropine sulfate, alfentanil, Amikacin, dexmedetomidine, fentanyl, labetalol, midazolam, milrinone, morphine vecuronium. **Antibiotics:** ambisome, caspofungin, cefuroxime, ciprofloxacin, clarithromycin, erythromycin, fluconazole, gentamicin, metronidazole, tobramycin, vancomycin **Other:** calcium gluconate, esmolol, GTN, insulin, lidocaine, potassium chloride, procainamide. NB assumes other drug diluted in glucose 5% **This list is not exhaustive – please refer to Medusa for full list.**
Y-site incompatible drugs and infusions	In general thought to be incompatible with 0.9% NaCl. Note that when sodium chloride used as a flush there do not appear to be any issues. Incompatible with aminophylline, bivalirudin, ceftazidime, co-amoxiclav, digoxin, furosemide, heparin, sodium bicarbonate, imipenem/cilastin, omeprazole, Piperacillin/tazobactam.

Glyceryl Trinitrate (GTN) | Peripheral or Central

Core Information

Drug name:	Glyceryl Trinitrate
Alternate names:	GTN, nitroglycerin
Presentation:	50mg in 50ml vial
Indications:	Acute heart failure, hypertensive emergencies, unstable angina/acute myocardial infarction
Storage:	Room temperature
Route:	Peripheral or central infusion
Dilution Instructions	Ready diluted
Usual dosage range	1-12mg/hr (1-12ml/hr)
Titration advice	Start at 1mg/hr or as instructed Adjust rate by 0.5-1mg/hr every 15minutes as needed, titrating to a target MAP/systolic BP set by clinicians.

Drug properties	
Clinical pharmacology	Glyceryl trinitrate is an organic nitrate compound and a short acting vasodilator. Preferably dilates the venous over the arterial system its mechanism of action is to generate the endogenous vasodilator nitric oxide (NO) by reacting with sulfahydryl groups of cell surface molecules. Due to sulfahydryl depletion with protracted infusion tolerance and reduced efficacy worsens the longer the patient is on the infusion.
Onset and duration of effect	Rapid onset of action (1-2 mins) Short duration due to rapid metabolism and short half-life of 3-5mins
Side-effects	Headache, dizziness, hypotension, tachycardia. Large doses can cause vomiting, blurred vision & restlessness. Rare cases of cyanosis and methaemoglobinaemia reported.
Cautions	Use cautiously in hypotensive, hypovolaemic or anaemic patients or heart failure due to obstruction. The BNF lists angle-closure glaucoma as a caution due to concerns of raised IOP but there is no evidence to support this. Be aware of likely possibility of development of tolerance with protracted infusion.
Contraindications	Do not use concomitantly with phosphodiesterase inhibitors (sildenafil, tadalafil); significant potentiation of hypotensive effect will occur-deaths have been reported due to this interaction.
Y-site compatible drugs and infusions	**ICU drugs:** Atracurium, cisatracurium, clonidine, dexmedetomidine, esmolol, labetalol, fentanyl, milrinone, morphine, propofol, remifentanil, vecuronium **Other drugs:** Aminophylline, amiodarone, argatroban, calcium chloride/gluconate, ceftolozane + tazobactam, fluconazole, gentamicin, haloperidol, heparin, insulin (soluble), lidocaine, linezolid, lorazepam, magnesium, mannitol, potassium chloride, tacrolimus, vancomycin **Compatible fluids:** glucose 5%, sodium chloride 0.9%, Hartmann's, Plasma-Lyte 148
Y-site incompatible drugs and infusions	Acetylcysteine, alfentanil, co-trimoxazole, levofloxacin, metoprolol, omeprazole, rocuronium.

Hydralazine	**Peripheral or Central**

Core Information

Drug name:	Hydralazine
Alternate names:	N/A
Presentation:	20mg in 1ml ampoules
Indications:	Pre-eclampsia/eclampsia, hypertension management in patients NBM, hypertensive emergency
Storage:	Do not store above 25°C
Route:	Central line or large peripheral vein
Dilution Instructions	Reconstitute 3 vials each with 1ml WFI. Dilute further with 0.9% NaCl to final volume of 60ml to give 1mg/ml concentration. **DO NOT PREPARE IN GLUCOSE**
Usual dosage range	**Bolus (PRN) dosing:** 10-20mg given as a slow bolus over 3-5 minutes (dilute in 10ml WFI). Repeat after 20-30minutes as needed. **Continuous infusion:** 3-18ml/hr (50-300mcg/min) Start at 12-18ml/hr. Once control established aim to reduce to maintenance rate of 3-9ml/hr if possible
Titration advice	Adjust in 1ml/hr (50mcg/min) increments every 20 minutes until BP controlled.

Drug properties	
Clinical pharmacology	Direct acting vasodilator-speculated to inhibit sarcoplasmic release of calcium and inhibit myosin phosphorylation. This reduces peripheral vascular resistance which can lead to compensatory baroreceptor reflex-increasing venous return and cardiac output. For this reason, concurrent use with beta-blocker (e.g. labetalol infusion) may be preferred if possible to mitigate against reflex tachycardia. Metabolised in the liver by acetylation which is polymorphic-some patients may be slow acetylators and be highly sensitive to its effects while others may be fast acetylators and require much larger doses. As such be aware of possibility of significant variability in response between patients. Changed and unchanged drug excreted via the kidneys.
Onset and duration of effect	Onset of effect within 5-30 minutes Duration 2-6hrs
Side-effects	Headache, tachycardia, hypotension, myocardial ischaemia, sodium and fluid retention (consider concomitant diuretic if a problem). Drug induced lupus has been shown to occur generally in slow acetylators, particularly in prolonged treatment (>6 months at doses >100mg/d) but may also exacerbate incipient lupus.
Cautions	Stroke, cardiac disease (e.g. immediately post MI).
Contraindications	Porphyria, known lupus erythematosus and related diseases.
Y-site compatible drugs and infusions	Caspofungin, hartmann's solution, heparin, hydrocortisone, potassium chloride, sodium chloride
Y-site incompatible drugs and infusions	Aminophylline, furosemide, **glucose solutions** (rapidly inactivated in contact with glucose-Y-site infusions must be in sodium chloride), meropenem

Labetalol | Peripheral or Central

Core Information

Drug name:	Labetalol Hydrochloride
Alternate names:	Nil
Presentation:	50mg in 10ml or 100mg in 20ml ampoules (5mg/ml)
Indications:	Management of pre-eclampsia/eclampsia, hypertensive crisis, aortic dissection
Storage:	Do not store above 25°C
Route:	Peripheral or Central. If 5mg/ml given peripherally monitor site for signs of extravasation. Give through large peripheral vein as solution is irritant
Dilution Instructions	On ICU preferred preparation is to give undiluted solution neat (5mg/ml) [unlicensed] Be aware ward protocol is to dilute to 1mg/ml concentration-this may lead to hyponatraemia and fluid overload at high doses.
Usual dosage range	**Bolus dose:** 25-50mg IV bolus. Repeat after 5-10mins if needed to max 200mg. **Infusion:** 20-200mg/hr
Titration advice	Usually for infusion start at 4mls (20mg)/hr. Double rate every 30 minutes as needed until BP stabilised at acceptable range.

Drug properties	
Clinical pharmacology	Labetalol is a mixed alpha-1 and beta (non-selective) adrenoceptor blocking agent. The ratio of alpha to beta blockade has been estimated as 1:3 and 1:7 for oral and intravenous forms respectively. Therefore, whilst it offers some vasodilatation, the IV infusion has a greater impact on BP through negative inotropic/chronotropic effect. It has been extensively studied and is the first line IV option in hypertension in eclampsia though note very high doses can provoke foetal bradycardia.
Onset and duration of effect	Onset of 5-10 minutes. Duration: 3-6hrs-continuous infusions may lead to accumulation and more protracted effect-be careful therefore not to over-shoot and cause hypotension as effect can be prolonged.
Side-effects	Postural hypotension, LV failure in pre-disposed patients due to negative inotropy, bronchospasm in asthma/COPD (non-selective beta blockade), hypotension. There are rare reports of liver injury-monitor LFTs if any signs of hepatic dysfunction develop.
Cautions	Strong caution to ambulating patients on labetalol IV due to risk of falls, first degree heart block, careful use concomitantly with other blood-pressure lowering medicines.
Contraindications	Avoid in 2nd/3rd degree heart block, asthma, cardiogenic shock, uncontrolled heart failure, untreated phaochromocytoma, other conditions associated with severe hypotension or bradycardia.
Y-site compatible drugs and infusions	**ICU infusions:** Alfentanil, amiodarone, atracurium, clonidine, dexmedetomidine, dobutamine, dopamine, GTN infusion, midazolam, milrinone, morphine, propofol, remifentanil, rocuronium, vecuronium **Other drugs:** Acetylcysteine, aminophylline, calcium gluconate, ceftazidime, clindamycin, co-trimoxazole, erythromycin, fentanyl, gentamicin, insulin infusion, levofloxacin, lidocaine, linezolid, lorazepam, magnesium sulfate, meropenem, metronidazole, paracetamol, potassium chloride, sodium nitroprusside, vancomycin **Fluids:** Glucose 5%, Hartmann's, sodium chloride 0.9%, PlasmaLyte 148, Sodium chloride with glucose mixture
Y-site incompatible drugs and infusions	Albumin, ceftriaxone, cefepime, ceftaroline, esomeprazole, furosemide, heparin, hydrocortisone sodium succinate, omeprazole, pantoprazole, sodium thiopentone

Methylene Blue | CVC only

Core Information

Drug name:	Methylthioninium Chloride
Alternate names:	Methylene Blue
Presentation:	5mg/ml (0.5%) 10ml ampoules
Indications:	Licensed for methaemoglobinaemia. Used off license to increase mean arterial pressure (MAP) and systemic vascular resistance in patients with septic shock/systemic inflammatory response syndrome. Also used off license for prophylaxis and treatment of Ifosfamide induced encephalitis.
Storage:	Room temperature
Route:	Central venous route ONLY
Dilution Instructions	No dilution required. It is recommended to attach a 0.2micron filter to the administration set as the colour of the solution may mask any particulates on visual inspection.
Usual dosage range **In obesity max dose has not been established. Use actual body weight. In extreme obesity consider adjusted body weight [expert opinion-no data]**	Loading dose: 2mg/kg over 15-30 minutes. Maintenance infusion: start at rate of 0.25mg/kg/hr for 1 hour then increase to 0.5mg/kg/hr for 1 hour then 1mg/kg/hr for 1 hour then 2mg/kg/hr for 1 hour. Infusions can continue for 6 hours – if longer infusion required, monitor for potential risk of methaemoglobinaemia.
Titration advice	Follow above dosing schedule **See full guideline for full administration instructions.**

Drug properties	
Clinical pharmacology	Methylene blue is a thiazine dye that is licensed for methaemoglobinaemia. Used off license to increase mean arterial pressure (MAP) and systemic vascular resistance in patients with septic shock/systemic inflammatory response syndrome through antagonism of nitric oxide and guanylate cyclase mediated vasodilation. It is also used off license for the prophylaxis or treatment of Ifosfamide induced encephalitis (please see full guideline for more information.)
Onset and duration of effect	No published data
Side-effects	Methaemoglobinaemia, transient increase in pulmonary vascular resistance, thrombocytopenia, discolouration of body fluids, may interfere with SPO2 reading, skin tattooing with extravasation.
Cautions	Renal impairment, pulmonary hypertension, patients taking serotonergic agents (increases risk of CNS toxicity and the potential of developing serotonin syndrome).
Contraindications	Pregnancy, G6PD deficiency, pre-existing methaemoglobinaemia (>5%), age <18yrs, hypersensitivity to methylene blue
Y-site compatible drugs and infusions	Glucose 5%
Y-site incompatible drugs and infusions	Sodium chloride 0.9%
Monitoring	Regular monitoring for development of methaemoglobinaemia. Blood gas analysis should be taken prior to the loading dose, 60 minutes and 120 minutes after the loading dose. If continuous infusion, monitor 60 minutes and 120 minutes after starting infusion and 4hourly thereafter. Note: If methaemoglobin levels are greater than 3% after bolus omit maintenance infusion. If methaemoglobin levels are greater than 6 % during infusion stop and monitor until less than 2%

Nicardipine | Central or large peripheral vein

Core Information

Drug name:	Nicardipine
Alternate names:	N/A
Presentation:	10mg in 10ml amps
Indications:	Blood pressure reduction in intracranial haemorrhage/acute stroke
Storage:	Room temperature
Route:	Central venous route if undiluted Large peripheral vein after dilution
Dilution Instructions	If diluting for peripheral use: Add the contents of 5 vials (50mg) to 200ml 5% glucose (incompatible with sodium chloride 0.9%) Final concentration 200 micrograms/ml Product can also be given undiluted: Draw up 50mg (50ml) into a 50ml syringe [CENTRAL ACCESS ONLY]
Usual dosage range	**Diluted product:** Start 3-5mg/hr (15-25ml/hr). Increase to max 15mg/hr (75ml/hr). Once blood pressure target reached reduce rate down to maintenance 2-4mg/hr (10-20ml/hr). If over 80 years old start at 1mg/hr (5ml/hr) and adjust in 0.5mg/hr increments **Undiluted product:** Start at 3-5mg/hr (3-5ml/hr), increased to max 15mg/hr (15ml/hr). Once blood pressure target reached reduce rate down to maintenance 2-4mg/hr (2-4ml/hr). If over 80 years old start at 1mg/hr (1ml/hr) and adjusted in 0.5mg/hr increments
Titration advice	Adjust in increments of 0.5-1mg/hr every 15 minutes. **For the diluted product this** = 2.5-5ml/hr adjustment every 15mins **For the undiluted product this** = 0.5-1ml/hr adjustment every 15 mins

Drug properties	
Clinical pharmacology	Nicardipine is a dihydropyridine calcium channel blocker available for parenteral infusion. It works by relaxing vascular smooth muscle leading to vasodilation of coronary and peripheral arterial vessels. This reduces systemic vascular resistance and improves myocardial oxygen delivery.
Onset and duration of effect	Usual onset within 15 minutes of infusion. Initial duration of action is short with a initial re-distribution of 3 minutes and an intermediate elimination phase of 40 minutes. However, with prolonged infusion, drug may accumulate with a terminal half life of 14hrs. Therefore, it is important to promptly reduce the infusion rate to the maintenance range once blood pressure control achieved.
Side-effects	Reflex tachycardia, headaches, lower limb oedema, palpitations, flushing, hypotension, nausea and vomiting. Can cause significant extravasation injury due to low pH-use peripheral protocol with caution
Cautions	Cardiac failure, suspected coronary ischaemia, pregnancy, hepatic dysfunction, portal hypertension, severe hypoalbuminaemia (increased free fraction). Presence of strong CYP3A4 inducers (e.g. phenytoin, carbamazepine, rifampicin, phenobarbital) or strong inhibitors (azoles, clarithromycin, ritonavir) may decrease or increase plasma levels respectively. May increase levels of ciclosporin or tacrolimus-monitor closely.
Contraindications	Decompensated liver failure, acute coronary syndromes, refractory hypoxaemia (may cause VQ mismatching by impairing hypoxic pulmonary vasoconstriction). The manufacturer contraindicates concomitant use with dantrolene infusion due to animal studies showing fatality when dantrolene was given with IV verapamil-confirmation of this effect with nicardipine is not known. Avoid with known fructose intolerance (contains sorbitol)
Y-site compatible drugs and infusions	Amikacin, aminophylline, aztreonam, calcium gluconate, chloramphenicol, clindamycin, co-trimoxazole, esmolol, fentanyl, gentamicin, glucose 5%, glyceryl trinitrate, labetalol, lidocaine, linezolid, magnesium sulfate, metronidazole, midazolam, milrinone, morphine, potassium chloride, sodium nitroprusside, tobramycin, vancomycin, vecuronium. **The above data is for the dilute protocol only. If giving undiluted use a dedicated cannula or discuss with pharmacy for advice**
Y-site incompatible drugs and infusions	Ampicillin, ceftolozane-tazobactam, furosemide, sodium bicarbonate, Hartmann's, thiopental, phenytoin.

Alfentanil	**Peripheral or Central**

Core Information

Drug name:	Alfentanil
Alternate names:	N/A
Presentation:	5mg/1ml amps (ICU strength) 1mg/2ml amps (theatres strength)
Indications:	Analgesia, sedation and ET tube tolerance in the intubated patient
Storage:	**CD** cupboard
Route:	Peripheral or central line
Dilution Instructions	Draw up 20mg (4ml) of alfentanil 5mg/ml Add to 36ml of 0.9% NaCl Final concentration=0.5mg/ml
Usual dosage range	0-2.5mg/hr (0-5ml/hr)
Titration advice	*Generally start at 0.25mg/hr (0.5ml/hr). *Adjust in 0.25-0.5mg/hr increments up to every 5minutes titrating to pain/comfort (NOT sedation) *If converting to/from morphine infusion: 1mg/hr morphine ~/=0.1-0.25mg/hr (0.2-0.5ml/hr) alfentanil 4mg/hr morphine ~/=0.4-1mg/hr (0.8-2ml/hr) alfentanil 7mg/hr morphine ~/=0.7-1.75mg/hr (1.4-3.5ml/hr) alfentanil 10mg/hr morphine ~/= 1-2.5mg/hr (2-5ml/hr) alfentanil

Drug properties	
Clinical pharmacology	Alfentanil is a synthetic opioid and a derivative of fentanyl. It has a higher potency and lipophilicity than morphine though less than fentanyl. Alfentanil is approximately 4-10x as potent as morphine and 90x as lipid soluble. It is metabolised in the liver to inactive metabolites. As such it does not accumulate in renal impairment. It also has a more rapid onset than fentanyl due to a greater fraction being unionised. Due to its lipophilicity prolonged infusion can lead to significant accumulation in tissue compartments and dosing confusion can lead to very high opioid intake if the potency difference with morphine is not taken into account.
Onset and duration of effect	Onset: 1-2 mins following a bolus Around 90-minute half-life with bolus dosing Accumulates with prolonged continuous infusion.
Side-effects	Nausea and vomiting Respiratory depression Hypotension Bradycardia Chest wall rigidity reported
Cautions	Hepatic failure-dependent on liver clearance-use only very low doses Hypotension/shock Respiratory failure Elderly/frail patients (use lower doses)
Contraindications	Hypersensitivity to alfentanil
Y-site compatible drugs and infusions	**ICU infusions**: Atracurium, cisatracurium, clonidine, dexmedetomidine, esmolol, Insulin, midazolam, morphine, propofol, rocuronium, sodium nitroprusside, vecuronium **Other drugs**: Acetylcysteine, aminophylline, amiodarone, bivalirudin, furosemide, heparin sodium, isosorbide dinitrate, labetalol, linezolid. **Fluid infusions**: glucose 5%, sodium chloride 0.9%, Glucose 4% with Sodium chloride 0.18% (“Dex-Saline”), Hartmann’s solution
Y-site incompatible drugs and infusions	Glyceryl trinitrate (GTN), omeprazole, thiopental sodium

Clonidine — Central or peripheral

Core Information

Drug name:	Clonidine
Alternate names:	Catapres™ (Brand name)
Presentation:	150 micrograms in 1ml solution for injection
Indications:	As an additional sedative agent when adequate sedation cannot be maintained with standard drugs. Agitation with tachycardia and hypertension especially upon ventilator weaning. Opiate and alcohol withdrawal reactions.
Storage:	Room temperature
Route:	Central or peripheral
Dilution Instructions	Draw up 5ml (750micrograms) of clonidine. Make up to a final volume of 50ml with 45ml of 0.9% NaCl Final concentration= 15micrograms/ml
Usual dosage range (In obese patients cap dosing weight at 100kg)	0.25-2microgram/kg/hr Exceptionally doses up to 3micogram/kg/hr at consultant discretion Consider loading dose of 50-75 micrograms over 10 mins prior to commencing maintenance infusion
Titration advice	Start at 0.5mcg/kg/hr. Increase infusion rate in increments of 0.25-0.5mcg/kg/hr every 1-2hrs as tolerated in terms of heart rate/blood pressure. Wean slowly to avoid rebound HTN

Drug properties	
Clinical pharmacology	Clonidine is a centrally acting alpha-2 agonist. Via activating central negative feedback mechanisms it reduces synaptic concentrations of noradrenaline within the locus coeruleus. This leads to dose related sedation, analgesia, anxiolysis and a reduction in requirement of other sedative and opioid agents. It produces a decrease in sympathetic tone with increase in vagal activity leading to hypotension and bradycardia. It does not depress respiration significantly.
Onset and duration of effect	Following a single IV dose onset of action is ~10minutes Half-life is 10-20hrs, rising to 41hrs in severe renal failure
Side-effects	Dry mouth (~50% patients), constipation, fluid retention, hypotension and bradycardia Colonic pseudo-obstruction rarely reported Rapid withdrawal produces rebound hypertension & tachycardia
Cautions	Use with extreme caution or avoid in patients with hypotension, bradycardia, low cardiac output or impaired LV function Enhanced hypotensive effect of other antihypertensive drugs Raynaud's & peripheral vascular disease Depression may be worsened with protracted use in patients with history of depression Renal failure leads to accumulation-consider lower doses.
Contraindications	Patients in shock, on significant vasopressor support or severe hypotension, bradycardia, heart block or cardiac failure. Porphyria
Y-site compatible drugs and infusions	**ICU infusions:** Alfentanil, amiodarone, atracurium, fentanyl, ketamine, labetalol, morphine, remifentanil, rocuronium, vecuronium **Other drugs:** Acetylcysteine, aminophylline, esmolol, furosemide, GTN infusion, heparin infusion, insulin, magnesium, potassium chloride, sodium nitroprusside, verapamil. **Fluid infusions:** glucose 5%, glucose 10%, sodium chloride 0.9%
Y-site incompatible drugs and infusions	Omeprazole

Dexmedetomidine	**Central or peripheral**

Core Information

Drug name:	Dexmedetomidine
Alternate names:	"Dexdor"
Presentation:	400 microgram/4ml vials 1000 microgram/10ml vials
Indications:	Sedation agent to achieve light sedation in patients too agitated to extubate/manage on NIV, who have failed conventional therapy
Storage:	Room temperature
Route:	IV infusion, CV infusion
Dilution Instructions: **For obesity use adjusted body weight [Expert opinion-limited data]**	**Standard (peripheral):** Draw up 20ml (2000 microgram) of dexmedetomidine Add to 230ml of 5% glucose/0.9% NaCl Final concentration 8mcg/ml **Concentrated (for CV infusion only):** Draw up 10ml (1000 microgram) of dexmedetomidine Add to 40ml of 5% glucose/0.9% NaCl Final concentration 20mcg/ml
Usual dosage range:	0.4-1.4 micrograms/kg/hr
Titration advice	Start most patients on 0.7mcg/kg/hr (0.4 if bradycardia) Titrate in 0.1mcg/kg/hr increments every 30-60 minutes; ideally achieve max tolerated rate (to max 1.4mcg/kg/hr) for several hours then review down-titrating other agents.

Drug properties	
Clinical pharmacology	Dexmedetomidine is a centrally-acting presynaptic α_2-agonist. It works in a similar fashion to clonidine but has 8x higher selectivity for the central alpha-2 receptor reducing cardiac and gastro-toxicity vs clonidine. It produces a light sedation state without significant inhibition of respiratory rate. It also mediates a reduction in blood pressure and can reduce spinal pain transmission.
Onset and duration of effect	Peak concentrations within 1hr. In an anaesthetic setting has an onset of action of around 15mins. However, clinical experience in ICU indicates may take 8-12hrs before significant anti-agitation effects are seen and other sedation can be withdrawn Terminal half life of 2hrs after discontinuation
Side-effects	Bradycardia, hypotension, nausea, blood glucose abnormalities, dry mouth
Cautions	Pre-existing hypotension, bradycardia or cardiac disease, haemodynamic instability, hepatic dysfunction
Contraindications	Severe haemodynamic instability, 2nd or 3rd degree heart block, acute CVA (stroke), patients requiring deep sedation. It should not be used early in admission (1st 48hrs) and should be discontinued after 48hrs if no benefit.
Y-site compatible drugs and infusions	**ICU drugs:** alfentanil, atracurium, cisatracurium, esmolol, morphine, propofol, remifentanil, rocuronium, thiopentone **Other drugs:** Aminophylline, amiodarone, calcium gluconate, ciprofloxacin, co-trimoxazole, dexamethasone, digoxin, fentanyl, fluconazole, furosemide, gentamicin, GTN, heparin, hydrocortisone, levofloxacin, lidocaine, magnesium, metronidazole, potassium chloride, sodium nitroprusside, tobramycin, vancomycin, **Compatible fluids:** Glucose 5%, sodium chloride 0.9%, Hartmann's,
Y-site incompatible drugs and infusions	Amphotericin B, diazepam

Midazolam	**Central or peripheral**

Core Information

Drug name:	Midazolam
Alternate names:	Nil
Presentation:	Pre-filled syringe: 50mg in 50ml Injection: 10mg in 2ml
Indications:	Agitation, sedation and ET tube tolerance in the intubated patient
Storage:	**CD** cupboard
Route:	Central or peripheral
Dilution Instructions:	Use a ready-diluted preparation if available, or dilute with glucose 5% or sodium chloride 0.9% to give a solution of 1mg in 1ml or 2mg in 1ml (Double-strength)
Usual dosage range:	IV bolus: 2.5-5mg when required IV infusion: 0.03-0.2mg/kg/hr
Titration advice	Titrate by 1mg/hr every 30 minutes according to target RASS

Drug properties	
Clinical pharmacology	Midazolam is a benzodiazepine with a short duration of action. The mechanism of action is indirect and is related to GABA accumulation and its affinity to benzodiazepine receptors. The anticonvulsant activity of midazolam is related to excess GABA action in the brain. Midazolam also acts on glycine receptors and produces a muscle-relaxing effect.
Onset and duration of effect	Elimination half-life of 1.5-2.5 hours. Prolonged infusion results in accumulation and longer elimination time (context sensitive half-time)
Side-effects	Respiratory depression, respiratory arrest, anterograde amnesia, paradoxical reactions, hyperactivity, hostility, rage reaction, aggressiveness, paradoxical excitement, tenderness at injection site, hypersensitivity, angioedema, anaphylactic shock, laryngospasm, cardiac arrest, bradycardia, hypotension, vasodilation, nausea, vomiting, sedation.
Cautions	Cardiac disease, children, debilitated patients (reduce dose), hypothermia (risk of severe hypotension, hypovolaemia (risk of hypotension), neonates, risk of airways obstruction and hypoventilation, vasoconstriction
Contraindications	Hypersensitivity to the active substance or benzodiazepines. Use of this drug for conscious sedation in patients with severe respiratory failure or acute respiratory depression.
Y-site compatible drugs and infusions	**ICU infusions:** Alfentanil, atracurium, cisatracurium, vecuronium dexmedetomidine, fentanyl, propofol, remifentanil, rocuronium. **Other drugs:** Acetylcysteine, amiodarone, anidulafungin, aprotinin, calcium gluconate, dopexamine, esmolol, gentamicin, glyceryl trinitrate, heparin, sodium nitroprusside (light protected), vancomycin. **Fluid infusions:** Glucose 5%, sodium chloride 0.9%, glucose 4% with sodium chloride 0.18% (“Dex-Saline”), glucose 10%
Y-site incompatible drugs and infusions	Hartmann’s solution, co-trimoxazole, furosemide, omeprazole, thiopental sodium

Morphine	**Central or peripheral**

Core Information

Drug name:	Morphine
Alternate names:	Morphine
Presentation:	10mg in 1ml injection 50mg in 50ml pre-filled syringe
Indications:	Analgesia, sedation and ET tube tolerance in the intubated patient
Storage:	**CD** cupboard
Route:	Central or peripheral line
Dilution Instructions:	IV infusion: dilute the required amount with sodium chloride 0.9% or glucose 5% to give a concentration of 1ml/ml (standard strength) or 2mg/ml (double strength).
Usual dosage range:	1-5mg/hr
Titration advice:	Titrate in 1mg/hr increments every 30 mins to achieve adequate analgesia

Drug properties	
Clinical pharmacology	Morphine is an opioid agonist indicated for the management of pain. It works by agonizing mu-opioid receptors.
Onset and duration of effect	Onset of action of 1-2 minutes and reaches peak concentrations in 5-15minutes. Half-life of 1.5-2 hours
Side-effects	Arrythmias, confusion, constipation, dizziness, drowsiness, dry mouth, euphoric mood, flushing, hallucination, headache, hyperhidrosis, miosis, nausea, palpitations, respiratory depression, skin reactions, urinary retention, vertigo, vomiting, withdrawal syndrome.
Cautions	Adrenal insufficiency, asthma, central sleep apnoea, convulsive disorders, current or history of mental health disorder, current or history of substance use disorder, debilitated patients, diseases of the biliary tract, elderly, hypotension, hypothyroidism, impaired respiratory function, inflammatory bowel disorders, myasthenia gravis, obstructive bowel disorders, prostatic hypertrophy, shock, urethral stenosis.
Contraindications	Hypersensitivity to the active substance or excipients, respiratory depression or insufficiency, obstructive airway disease, cerebral trauma, increased intracranial pressure, coma, convulsive disorders, acute alcoholism, renal failure, ureteral stenosis, pancreatitis, liver failure, gall-bladder dysfunction, ileus, inflammatory bowel disease, hypotension with hypovolaemia, prostatic hypertrophy, myxoedema, phaeochromocytoma, concurrent administration of MAO inhibitors.
Y-site compatible drugs and infusions	**ICU infusions:** alfentanil, atracurium, cisatracurium, clonidine, dexmedetomidine, fentanyl, ketamine, labetalol, milrinone, propofol, remifentanil, vecuronium. **Other drugs:** Acetylcysteine, aminophylline, amiodarone, anidulafungin, aprotinin, calcium chloride, co-trimoxazole, dopexamine, esmolol, gentamicin, glyceryl trinitrate, heparin, insulin, isosorbide dinitrate, magnesium sulfate, metronidazole, midazolam, potassium chloride, salbutamol, sodium nitroprusside (light protected), thiopental sodium, vancomycin. **Fluid infusions**: compound sodium lactate, glucose 5%, glucose 10%, glucose 5% in sodium chloride 0.45%, sodium chloride 0.9%.
Y-site incompatible drugs and infusions	Omeprazole.

Propofol	Central or peripheral

Core Information

Drug name:	Propofol
Alternate names:	Propofol-Lipuro, Diprivan, Propoven
Presentation:	1% 100ml vial, 1% 50ml vial
Indications:	Sedation and ET tube tolerance in the intubated patient
Storage:	Store below 25°C, NB must be stored in locked cupboard or drawer
Route:	Central or peripheral
Dilution Instructions:	No dilution needed, concentration = 10mg/ml
Usual dosage range: Induction doses (if weight based) used IBW to avoid excess hypotension Use IBW to assess risk of PRIS (Intensive care society recommendation)	1-30ml/hr For purpose of surveying risk of PRIS consider calculating weight-based infusion dose: 0.5-4mg/kg/hr
Titration advice	Titrate in 1-2ml/hr increments every 5-10mins according to target RASS. Monitor BP while up-titrating as may reduce as propofol rate increases.

Drug properties	
Clinical pharmacology	Propofol is a short-acting intravenous general anaesthetic agent. It works by positive modulation of GABA through GABA-A receptors.
Onset and duration of effect	15-30 seconds
Side-effects	Hypotension, bradycardia commonly. Prolonged infusions at high infusion rates may cause hypertriglyceridaemia, particularly in combination with TPN. Infusion rates >4mg/kg/hr for >48hrs are associated with the rare complication of propofol infusion syndrome. Zinc deficiency also reported due to chelation by EDTA preservative in the formulation.
Cautions	PRIS (Propofol related infusion syndrome) , haemodynamic shock
Contraindications	Propofol should not be used in patients with a known hypersensitivity to propofol. Prolonged infusions (>48-72hrs) are not recommended for children <16yrs on ICU due to increased risk of PRIS. The product license contraindicates use in patients with peanut or soy allergy though there is no strong evidence for this and consensus of the Royal College of anaesthetists is that it may be used in these patient groups with caution.
Y-site compatible drugs and infusions	**ICU infusions:** alfentanil, dexmedetomidine fentanyl, ketamine, labetalol, midazolam, milrinone, morphine, remifentanil, vecuronium **Other drugs:** Aciclovir, aminophylline, calcium gluconate, esmolol, furosemide, fluconazole, glyceryl trinitrate, heparin, insulin, mannitol, magnesium sulfate, potassium chloride, sodium nitroprusside (light protected), thiopental **Fluid infusions**: glucose 5%, sodium chloride 0.9%, Hartmann's solution
Y-site incompatible drugs and infusions	Calcium chloride, gentamicin, plasmalyte 148, phenytoin, methylprednisolone, verapamil

Remifentanil	**Central or peripheral-DO NOT BOLUS**

Core Information

Drug name:	Remifentanil
Alternate names:	N/A
Presentation:	1mg, 2mg and 5mg vials
Indications:	Sedation and ET tube tolerance in the intubated patient
Storage:	**CD** cupboard
Route:	Central or peripheral
Dilution Instructions:	Add 5ml WFI to a 5mg vial to reconstitute. Further dilute with 45ml 0.9% NaCl or 5% glucose Final concentration 100mcg/ml
Usual dosage range: (Use ideal body weight in obesity)	Starting rate: 6-9 micrograms/kg/hr Maintenance: 1.5-12mcg/kg/hr. Higher doses can be used at discretion of duty consultant (max 45mcg/kg/hr).
Titration advice	Start at 6-9mcg/kg/hr Adjust in increments of 1.5mcg/kg/hr every 3-5mins according to analgesic requirements. TREAT LIKE AN INOTROPE-DO NOT BOLUS!

Drug properties	
Clinical pharmacology	Remifentanil is a fentanyl derivative and is a potent, short-acting, selective mu-receptor agonist. It is metabolised rapidly by non-specific blood and tissue esterases into clinically inactive metabolites. The elimination is independent of infusion duration and renal and hepatic dysfunction.
Onset and duration of effect	Remifentanil has a very rapid onset of action of action of approximately one minute and an elimination half-life of 10 minutes.
Side-effects	Skeletal muscle rigidity, bradycardia, hypotension, acute respiratory depression, apnoea, cough, nausea, vomiting, pruritis, post-operative shivering, hypomagnesaemia, dependency, post—operative aches, constipation, hypoxia and post-operative hypertension. Bolus dosing associated with severe bradycardia-DO NOT BOLUS.
Cautions	Within 5-10 minutes of discontinuation of remifentanil, patients can be left with no residual opioid activity – other analgesia must be considered in patients with rapid withdrawal of remifentanil. In obesity, use ideal body weight rather than actual weight. In the elderly, reduce initial dose by 50%.
Contraindications	Remifentanil is contra-indicated for epidural and intrathecal use due to glycine being present in its formulation. It is contraindicated in patients with hypersensitivity to the active substance or other fentanyl analogues. Remifentanil is also contra-indicated for use as the sole agent for induction of anaesthesia.
Y-site compatible drugs and infusions	**ICU infusions:** atracurium, cisatracurium, clonidine, dexmedetomidine, midazolam, labetalol, propofol, rocuronium, vecuronium **Other drugs:** Aciclovir, acetylcysteine, amikacin, aminophylline, amiodarone, calcium gluconate, cefotaxime, cefoxitin, ceftriaxone, ciprofloxacin, clindamycin, co-trimoxazole, dexamethasone, esmolol, fluconazole, furosemide, gentamicin, glyceryl trinitrate, heparin sodium, hydrocortisone, hydromorphone, insulin, isosorbide dinitrate, magnesium sulfate, mannitol, metronidazole, piperacillin with tazobactam, sodium nitroprusside, thiopental sodium, vancomycin **Fluid infusions**: glucose 5%, glucose 5% and sodium chloride 0.9%, Hartmann's solution, sodium chloride 0.9%, sodium chloride 0.45%
Y-site incompatible drugs and infusions	Amphotericin B (if remifentanil concentration above 25micrograms in 1ml), Omeprazole and diazepam.

Atracurium	**CVC (1st line), peripheral (2nd line)***

Core Information

Drug name:	Atracurium
Alternate names:	Atracurium besilate
Presentation:	10mg/ml amps; available as 2.5ml (25mg), 5ml (50mg) and 25ml (250mg) sizes
Indications:	Neuromuscular blockade in intensive care (see Neuromuscular blockade guideline on Portsmouth ICU website)
Storage:	Store ampoules in fridge
Route:	Central venous route preferred Whilst the product *can* be given peripherally its low pH and osmolarity make it irritant/damaging if it extravasates so central route strongly encouraged. Large peripheral line only
Dilution Instructions	Draw up 25ml of atracurium solution (250mg) and administer neat. Concentration=10mg/ml
Usual dosage range (in obesity use ideal body weight)	0.3-0.6mg/kg/hr Max 1.77mg/kg/hr
Titration advice:	Start at 0.3mg/kg/hr. Adjust infusion rate by 10% every 30 mins up/down to achieve target 2 twitches on train-of-four as per DDCQ NM blockade guideline

Drug properties	
Clinical pharmacology	Atracurium is a non-depolarizing neuromuscular blocker. It works by blocking the action of acetylcholine in the synaptic cleft at the motor endplate. This leads to paralysis and muscle relaxation, reducing motor tone. In ARDS patients with ventilator desynchrony atracurium may permit lung protective ventilation by decreasing work of breathing, abolishing resting muscle tone and preventing spontaneous respiratory efforts. Atracurium, unlike rocuronium, spontaneously degrades at physiological pH and temperature (Hoffman degradation) so metabolism is independent of renal and liver function which is advantageous is multi-organ dysfunction. Small reductions in heart rate, MAP and CVP maybe seen
Onset and duration of effect	Onset 2-3minutes Duration 20-35mins
Side-effects	Histamine release (if problematic consider cisatracurium) Hypotension Bronchospasm Bradycardia Exacerbation of ICU acquired weakness (worsened by concomitant steroids) Anaphylaxis
Cautions	Cardiovascular disease, renal failure (response may be less predictable), hypothermia (activity can be prolonged-consider lower doses), neuromuscular diseases, myasthenia gravis (use lower than standard doses-paralysis can be prolonged and underlying disease exacerbated). Caution if hypersensitivity reported to other neuromuscular blockers (cross-reactivity possible)
Contraindications	Known allergy to atracurium or cisatracurium
Y-site compatible drugs and infusions	**ICU infusions**: Alfentanil, cisatracurium, clonidine, dexmedetomidine, labetolol, midazolam, milrinone, morphine, remifentanil, rocuronium, vecuronium. **Other drugs**: Acetylcysteine, amiodarone, cefuroxime, clarithromycin, co-trimoxazole, esmolol, fentanyl, gentamicin, glyceryl trinitrate, hydrocortisone, insulin, isosorbide dinitrate, lorazepam, sodium nitroprusside, vancomycin. **Fluid infusions**: Glucose 5%, Hartmann's solution, sodium chloride 0.9%, sodium chloride 0.18% & glucose4%.
Y-site incompatible drugs and infusions	Alkaline solutions, aminophylline, diazepam, furosemide, omeprazole, propofol and thiopental sodium.

Cisatracurium	**CVC (1st line), peripheral (2nd line)**

Core Information

Drug name:	Cisatracurium
Alternate names:	Cisatracurium besilate
Presentation:	150mg in 30ml vials 20mg in 10ml vials [Caution-not suitable for ICU]
Indications:	Neuromuscular blockade in ICU- see neuromuscular blockade guideline on Portsmouth ICU website
Storage:	Store vials in fridge
Route:	Central access preferred due to low pH and tonicity. If giving peripherally* ensure given via large peripheral line
Dilution Instructions	Give undiluted, draw up 60ml (300mg) of drug solution into a syringe. Final concentration 5mg/ml
Usual dosage range (In obesity use ideal body weight)	300-600mcg/kg/hr
Titration Advice	Start at 300mcg/kg/hr. Adjust infusion rate up/down in 10% increments every 30 mins to achieve target 2 twitches in train of four as per DCCQ NM blockade guideline

Drug properties	
Clinical pharmacology	Cisatracurium is one of ten possible isomers of atracurium. Its pharmacology is very similar. One of the metabolites of atracurium metabolism, laudanosine, which is epileptogenic in animal models, accumulates with prolonged infusion of atracurium in renal failure. This may be less extensive with cisatracurium. Note no toxicity has been documented in humans. Non-IgE related histamine release does not appear to occur with cisatracurium compared with atracurium. Cisatracurium has a very low risk of anaphylaxis. Like atracurium clearance is independent of renal or liver function.
Onset and duration of effect	Onset 2-3minutes Duration 55-65mins
Side-effects	Hypotension Bradycardia Exacerbation of ICU acquired weakness (worsened by concomitant steroids) Anaphylaxis-low risk
Cautions	Cardiovascular disease, renal failure (response may be less predictable), hypothermia (activity can be prolonged-consider lower doses), neuromuscular diseases, myasthenia gravis (use lower than standard doses-paralysis can be prolonged and underlying disease exacerbated). Caution if hypersensitivity reported to other neuromuscular blockers (cross-reactivity possible)
Contraindications	Known allergy to atracurium or cisatracurium
Y-site compatible drugs and infusions	**ICU infusions**: Alfentanil, atracurium, dexmedetomidine, fentanyl, Glyceryl trinitrate (GTN), Midazolam, morphine, remifentanil, **Other drugs**: calcium gluconate, esmolol, gentamicin, glyceryl trinitrate, magnesium sulphate, mannitol, metronidazole, vancomycin **Fluid infusions**: Glucose 4% with Sodium chloride 0.18% ("Dex-Saline"), glucose 5%, sodium chloride 0.9%
Y-site incompatible drugs and infusions	Hartmann's solution, Thiopental sodium, Propofol, Heparin, sodium nitroprusside. Aminophylline & co-trimoxazole depend on concentration-discuss with pharmacy.

Rocuronium	**Central or peripheral**

Core Information

Drug name:	Rocuronium
Alternate names:	Esmeron (brand name)
Presentation:	50mg in 5mL injection
Indications:	Neuromuscular blockade in intensive care (see Neuromuscular blockade guideline on Portsmouth ICU website).
Storage:	Store vials at 2°C-8°C (in fridge)
Route:	Central venous route preferred Whilst the product *can* be given peripherally its low pH and osmolarity make it irritant/damaging if it extravasates so central route strongly encouraged. Large peripheral line only
Dilution Instructions:	IV injection: give undiluted IV infusion: give undiluted or dilute with sodium chloride 0.9% or glucose 5% to a convenient concentration. Suggested concentration in critical care is 500mg in 50ml (10mg in 1ml neat/undiluted).
Usual dosage range: (for obese patients use ideal body weight initially and adjust to effect)	300-600mcg/kg/hr
Titration advice:	Start at 300mcg/kg/hr. Adjust infusion rate up/down in 10% increments every 30 mins to achieve target 2 twitches out of train of four as per DCCQ NM blockade guideline.

Drug properties	
Clinical pharmacology	Rocuronium is a non-depolarising neuromuscular blocker with a rapid onset. It is 6-8 times less potent and is more lipophilic than vecuronium; most of the drug is taken up by the liver and eliminated via the bile. It is more likely to cause anaphylactoid reactions than pancuronium or vecuronium.
Onset and duration of effect	The onset of Rocuronium is around 75 seconds and has a clinical duration of 33 minutes.
Side-effects	Hypersensitivity, anaphylactoid reactions, tachycardia, hypotension, bronchospasm, apnoea, respiratory failure, angioneurotic oedema, urticaria, rash, muscular weakness, steroid myopathy, prolonged neuromuscular block and delayed recovery from anaesthesia.
Cautions	Cardiovascular disease (reduce rate of administration), electrolyte disturbances (response unpredictable), fluid disturbances (response unpredictable), hypothermia (activity prolonged, lower doses required), myasthenia gravis (lower doses required), neuromuscular disorders (response unpredictable).
Contraindications	Hypersensitivity to Rocuronium or any of the excipients.
Y-site compatible drugs and infusions	**ICU infusions**: Alfentanil, atracurium, clonidine, dexmedetomidine, dobutamine, fentanyl, labetalol, midazolam, milrinone, remifentanil and vecuronium. **Other drugs:** Acetylcysteine, aminophylline, amiodarone, aprotinin, dopexamine, esmolol, heparin sodium, isosorbide dinitrate, meropenem, meropenem with vaborbactam, paracetamol **Fluid infusions:** glucose 5%, glucose 5% in sodium chloride 0.18%, Hartmann's solution, Plasma-Lyte148,
Y-site incompatible drugs and infusions	Amphotericin, amoxicillin, azathioprine, dexamethasone, diazepam, enoximone, erythromycin, furosemide, glyceryl trinitrate, hydrocortisone sodium succinate, insulin, methylprednisolone, micafungin, omeprazole, thiopental sodium and vancomycin.

Thiopentone	**Central line** (peripheral acceptable for bolus dose)

Core Information

Drug name:	Thiopentone sodium
Alternate names:	Thiopental sodium
Presentation:	Available as 500mg and 1g vials
Indications:	Status epilepticus, raised ICP (Consultant intensivist/neurosurgeon request only.)
Storage:	Do not store above 25°C
Route:	Intravenous – central line ONLY for infusions
Dilution Instructions: **NB infusion stability varies by brand:** -Advanz® brand-discard after 6hrs -PanPharma® brand-discard after 9hrs	**For bolus dosing:** Reconstitute 500mg with 20ml 0.9% NaCl to give a 25mg/ml solution. Give boluses *slowly* over 15 seconds to avoid hypotension **Continuous infusion:** Reconstitute 1g with 20ml water for injection (10ml for each 500mg vial) Remove 20ml from a 250ml bag of 0.9% NaCl or 5% glucose Add 1g in 20ml of thiopentone to the bag to give a 4mg/ml final concentration.
Usual dosage range: **In obesity use Adjusted body weight**	Convulsive states: IV bolus: 75-125mg; Loading doses up to 3-5mg/kg may be need for barbiturate coma IV infusion: 3-5mg/kg/hr to induce coma for seizure suppression. Titrate infusion to burst suppression pattern on EEG. Neurological patients with raised ICP: IV bolus: 1.5-3mg/kg of body weight may be given to reduce elevations of ICP if controlled ventilation is provided. Repeat as necessary
Titration advice	Following loading dose start patient on 3mg/kg/hr. For titration to effect seek expert guidance. Consultant to lead on dose adjustment

Drug properties	
Clinical pharmacology	Thiopentone is a barbiturate. Barbiturates reduce cerebral metabolism and reduce cerebral metabolic demands and cerebral blood volume. They can also reduce blood pressure and may adversely affect cerebral perfusion pressure.
Onset and duration of effect	Rapid onset – hypnosis is produced within 30-40 seconds. Typical half-life 6-12hrs though reportedly slower in obese patients (26-28hrs) Context sensitive half-time after prolonged infusion may approach 60hrs.
Side-effects	Heart arrhythmias, myocardial depression, hypotension, somnolence, delayed wakening, headache, dizziness, respiratory depression, bronchospasm, laryngospasm, coughing, snoring, shivering, malaise fatigue, hypokalaemia, hyperkalaemia, anorexia, anaphylaxis, hypersensitivities and allergic reactions. Extravasation can cause venous irritation and tissue damage due to high pH.
Cautions	Special care is needed in patients with: hypovolaemia, severe haemorrhage, burns, cardiovascular disease, myasthenia gravis, adrenocortical insufficiency, cachexia, raised intracranial pressure and raised blood urea. Dose reductions are recommended in shock, dehydration, severe anaemia, hyperkalaemia, toxaemia and metabolic disorders. Increased doses may be necessary in patients who have either a habituation or addiction to alcohol or drugs of abuse. Thiopentone causes re-distribution of potassium to the intracellular compartment and then rebound hyperkalaemia when infusion is stopped-monitor potassium carefully and ideally gradually taper off infusion. Thiopentone is metabolised primarily by the liver – doses should be reduced in hepatic impairment.
Contraindications	Hypersensitivity to barbiturates, respiratory obstruction, acute asthma, severe shock and dystrophia myotonica. Any barbiturate is contra-indicated in porphyria.
Y-site compatible drugs and infusions	Dexmedetomidine, glucose 5%, plasma-lyte 148, sodium chloride 0.9%
Y-site incompatible drugs and infusions	Amikacin, benzylpenicillin, codeine, fentanyl, glycopyrronium bromide, morphine, pethidine, prochlorperazine and suxamethonium. As Thiopentone is strongly alkaline, it is also incompatible with acids, acidic salts and solutions.

Evidence Base

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UKCPA Critical Care Pharmacist Forum-Personal communication

Guideline written by Joe Tooley-Lead ICU pharmacist, Lauren Choi-ICU pharmacist and Kendall Stevens-ICU pharmacist
Joe Tooley-Lead ICU pharmacist manages this guideline
See Trust Policy for the Production of Drug Therapy Guidelines
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Appendix A: Calculating Adjusted body weight from Ideal body weight

Ideal body weight should be derived from height, (which in turn can be estimated via ulnar length using tables in each ICU bedspace)

Adjusted body weight (kg) = Ideal body weight (kg) + 0.4[Actual BW(k) – Ideal BW(kg)]