Cardiac Anaesthesia and ICM Pocket book

University Hospital Southampton

Name……

Assignment Number……

First edition

N Goddard and J Huber

June 2019

Table of Contents

Ch. 1 - Useful contacts

Theatre/ Catheter/ Ward Areas

Cardiac Theatres

Theatre A	1986	Theatre B	1987
Theatre C	1988	Theatre 3	3413
Theatre 4	8949	Coffee Room	4528
Theatres Office	4531		

Theatres Contacts:

Case Managers	bl 2166	Office	5333/8686
Coordinator	bl 9217	Office	4531
O/C CT Registrar	bl 9211	O/C CT SHO	bl 2311
CT Registrar office	3674		
Main Th Coord	bl 2894	Perfusion	6930
PPM Techs	bl 9073	Office	3639
ICU Techs	bl 2317	Office	6890
Transfusion	4620	Theatre 12	4073
An Support ODP	bl 9266	F Lev Recov	4396
TAs	07795 306370 / bl 1489		
NB 4	1062	Angio V Room	4200

[Send > 08:00. Team brief 08:20]

Theatre Lists:

Case managers office (D-level North wing admin offices, End of CICU, through access door) day before provisional > approx 1600.

Catheter Labs:

Cath Lab 1	4547/3459	Recep	4233
Cath Lab 2	4535/3126	CLDU	4420
Cath Lab 3	8206/3124	CLDU SR	3434
Cath Lab 4	4534/1081	Hybrid	5602
Cath Lab 5	3996	Hyb AR	5600

Lists -> CLDU (Paper) or 'cardss' login -> G drive-> cathlabs-> lists

Wards:

CHDU (Med)	6835	CHDU (Sur)	6836
CHDU (SR)	6903	CCU	8570/8572
CLDU	4420	HF Unit	3140
E1	6470/3267	E2	6473/3206
E3G (Right)	6472	E3B (left)	4111
E4	6498/3206	D4	8468
ED Resus	4979		

F10/SDU: 6471 (Reception)

Green	3809	Orange	3722
Purple	3710	Yellow	348
Blue	8066		

Ward Team contacts:

ANP: bleep 1 2315 / bleep 2 2330/ Office 8182/3872
CT SHO bl 1511/ OC bl 2311, SpR bl 2472, OC bl 9211

CICU:

Blue Side:		**Pink Side:**
Nursing stn	6122	5080
	3574	4394
Office	4158	4273
Ward Clerk	6121	5923
Coffee Room		1240
Copier		6121/3245

Bed Spaces:

Blue 8	1889	Pink 8	1895
Blue 7	1890	Pink 7	1899
Blue 6	1896	Pink 6	1900

Blue 5	1897	Pink 5	1901
Blue 4	1891	Pink 4	1838
Blue 3	1892	Pink 3	1869
Blue 2	1893	Pink 2	1904
Blue 1	1894	Pink 1	3688
Telephone redirect		*3	

Staff:

Fellow	bl 1660	SPR	bl 2310
Cons	bl 2251	Sister i/c	bl 1491

CICU-related useful contacts:

Acute Pain Team	bl 2974
Cardiology SpR	bl 2390
Chest XR (Day/North wing)	8347

Chest XR (OOH = A+E)	3294
CIS Team bl 1794/ Office	4496
CT Head Requests	6588
CT Scanner (B Level)	3479
Echo (Requests)	6368
Endoscopy (TOE probes)	4791
General Surgery SpR	bl 9990
Main XR	4040
Microbiology	4203/6408/bl 2216
Neuro SpR	bl 2580
Nurse practitioners	8182/bl 9195
Pacemaker Techs	3639/bl 9073
Pharmacy	6313/bl 2408
Radiology Registrars Room	3657
Stroke Team SN	bl 1592
Techs ICU (Trauma)	1874

Techs ICU (Other)	9297
Trauma Scanner Registrars Seat	8002
Vascular Day Bleep holder	bl 1322

CICU Emergencies:

1. Chest opening/ return to theatre:

- Cardiac Coordinator bl 9217
- Cardiac Theatres Office 4531
- Perfusion Office 6930
- Perfusion bl 2322
- ODP Support bl 9266
- Transfusion 4620
- Theatre Coordinator bl 2894

2. Crash Call – 2222

Ask for “Cardiac Surgical Team + Cardiology Registrar” + location CICU

3. Other need for on call perfusionist out of hours:

- Names located on Blue side Whiteboard

- Numbers (+ Cons/Regs) Blue side Flip charts

Anaesthetic Contacts:

Emergency theatres team	2222

Consultants

Cardiac CICU consultant	bl 2251
Maj Trauma Anaes Consultant	bl 1783
Named Anaes Consultant	bl 1646
Obstetric Anaes Day Consultant	bl 2372

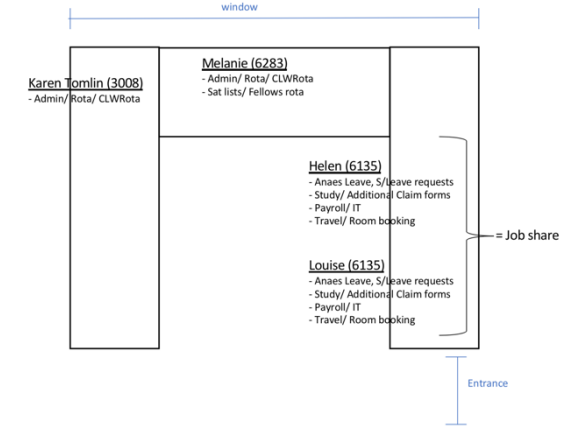
Trainees and fellows

Anaesthetic Coordinator SpR	bl 2265
CICU (Anaes) SpR	bl 2310
CICU Fellow	bl 1660
GICU SpR	bl 2110
Neuro Anaes SpR	bl 2510
Obstetric Anaes SpR	bl 2410
Paeds Anaes SpR	bl 2210
Trauma Anaesthesia SpR/CEPOD SHO	bl 2050

Allied staff:

ODP (Anaes support)	bl 9266
ODP (Maj Trauma)	bl 1784
Theatre coordinator	bl 2894

Anaesthetic Admin Team



The admin office

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Department of Anaesthetics

MP 24, E-level Centre Block,

SGH, Tremona Road, Soton. SO16 6YD.

Fax: 02381 20 4348 Tel: 20 6135/6720

Coffee room	3367
Switchboard	02380 777222
Sue Denton	8707

Hospital useful contact info

MedicalHR@uhs.nhs.uk	Reception 02381 206525
Payroll Helpdesk	0303 123 1144
Sylvia Richards (tr admin manager)	6741
Travelwise	Travelwise@uhs.nhs.uk or 4133
	Mon – Thurs 9-5pm, Fri 9-3pm (lines 4.30pm)
OOH Security	02381 20 4122 or security@uhs.nhs.uk

Spire (02380) 775544 or #7473 direct

Spire ICU	2297	Spire HDU	2353
Spire ICU	(02380) 764353		
Ward 1	2373/4	Ward 2	2372
Pathology	2328		

IT:

Help Desk (IT)	6000
JAC	4190
eprescribing@uhs.nhs.uk	bl 1800
PACS	4390
Metavision 4496	
CLW Rota	uhs.clwrota.com

- PACS Shortcut for WRs:

These can be found in Worklists--> Role Worklists-->Clinician --> Wards -->CICU less than 3 days

This will pick up all patients who have had any scans (including CXRs) in the last 3 days - fairly sensitive for patients who are on the CICU currently

- Metavision Team:

Charlie Pugh, Ryan Beecham, Sophie, Matt Cordingly:

Ext 4496/ criticalcareCIS@uhs.nhs.uk

- Desktop/ ipad Login:

www.ccmv.uk

Scheduled meetings:

Mon AM - Cardiac M+M (1st of Month, 7.30am)

Tues PM - SPR/ fellows Teaching (pm)

Wed AM - Echo Teaching (7.30am)

Frid AM – Cardiac Ed Meeting (7.30am)

----------Non cardiac:----------

Frid AM – Cardiology Grand Round 08:30, heartbeat

Cardiac MDT

TAVI MDT

Aortic MDT – 1st + 3rd Tuesdays/month (GMT office)

Thoracic/ Respiratory Radiology Meeting (Big Screen) – TUES lunchtime, Friday PM

Management:

Case Managers	8686/5333
	bl 2166
Bed Manager (Cardiac)	bl 2365
Matron' s office (Jenny/ Kate)	5943/ pa 1846
Fiona Lidell	8727/pa 4241

Site (Jake or Sarah)	3531
Materials Management (Daryl)	3561

Useful Codes:

(Write down your own useful codes here…

Ch. 2 – Cardiac Theatres (Perioperative)

Preoperative Assessment:

Premeds (guide only):

> 80 years:

- Oxygen
- Oramorph 5-10mg (or none)
- Temazepam 5 – 10mg (or none)

70 - 80 years:

- Oxygen
- Oramorph 10-20mg
- Temazepam 10-20mg/ Lorazepam 1mg

< 70 years:

- Oxygen

- Oramorph 10 - 20mg OR Morph IM 5-10mg

- Lorazepam 1-2mg OR Temazepam 20mg

Other options:

- hyoscine 0.2-0.4mg IM

- *Caution obese /elderly*

Anaesthetic Room:

'Standard' Drugs (subject to variation):

- Fentanyl 1000 (20mL syringe)

- Midazolam 10mg (10mL syringe)

- Muscle relaxant – PANC/ROC/VECuronium

- Saline (10mL syringe)

- Phenyl Strong = 10mg/10mL

- Phenyl weak = 100mcg/mL

- Tranexamic Acid 2g (20mL syringe) + 1g (10mL)

- Cefuroxime x 2 (1.5g + 1.5g)

- Heparin 300mcg/kg

- Propofol 1% 10mL + 50mL via pump

(2nd Line Abx = Vancomycin 1g + Gent 120-160mg)

Equipment Checks (standard):

- TOE Machine working/on + probe available

- Anaesthetic machine check x 2

- Metavision check on/working x 2

- Haemocron Junior (ACT)

- Double plate (Art/CVC + spare), lines, fluids

- BIS/ NIRS/ DCV Pads - if indicated

- Pacing box battery + Defibs working

- Warmer (indi +/- B.Hugger x 2)

DHCA (Arch, dissection, descending Aorta):

- Consider dexamethasone 0.5mg/kg

- ICE

- NIRS

- Arterial lines pre and post Arch (red = proximal)

- Line splitter

TA TAVI:

- As per standard open procedure but heparin 100mcg/kg

- Bodyguard pump (yellow) + Bupivicaine 0.125% 8mL/hr to prescribe on JAC (extrapleural = Local other) + arrange via Acute pain service (bleep 2974)

- Norad 4mg/50mL at start

- See cath lab anaesthetic room wall for further information + equipment – *ref: TA TAVI v9b*

TF TAVI:

- Midazolam 5mg/5mL syringe

- Fentanyl x 2 ampoules (unopened)

- Rocuronium 100mg/10mL syringe

- Strong/ Weak phenyl

- Propofol 1% in 20mL/50mL (via TIVA set)

- Phenyl 100mcg/mL 50mL (via TIVA Set)

- Cefuroxime 1.5g

- Lidocaine 1% 2mL syringe

- Consider Bupivicaine 0.25/0.5% x 3 vials 10mLs for block

- Protamine (at end)

- See cath lab anaesthetic room wall for further information + equipment – *ref: TF TAVI v9b*

EP:

- Midazolam 1-2mg 2mL syringe

- Fentanyl 100-200mcg 5mL syringe

- Propofol 1% 20mL

- ROC/VECuronium

- Dexamethasone/ondansatron +/- paracetamol IV

- Phenylephrine infusion + 10mL + pump

- Blue valve, **NOT** 3 way octopus for IV – use double line splitter instead as no fluid flow through octopus

- Reversal agent

- Fluids hanging (but may **give little** due to ablation fluids + risk HF in context poor LV)

- Often listed as AF ablation (redo) +/- TOE. Sometimes VT ablation or syndromes (WPW common). Some poor LV's

+/- lead extractions (CRTD/P or SC ICD). May need CICU bed…

TAAA:

- NAC = 10g neat via 50mL + Dex 0.5mg/kg if DHCA

- See guide for LHB cases (in theatre C AR)

- OLV + scopes/ catheters

- Spinal drain + monitoring set

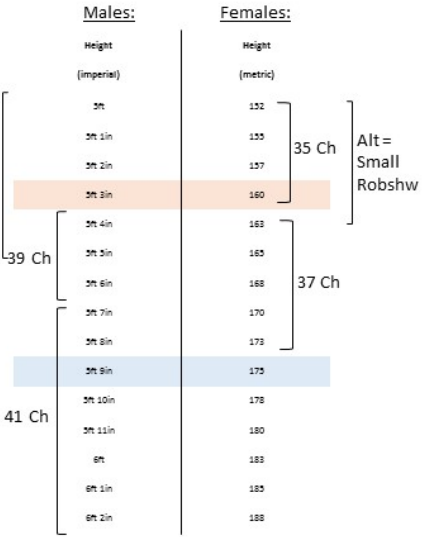
- Splitters + long cables

(see over for DLT selection)

DLT Selection:

Ave

bel
(Ref
ww
Ave
- Mc



Tric

- Us

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- Leave bronchoscope in Tracnea when redirecting tube

- No Bougies!

- **Bronchial Blockers** -> Arndt/ E-Z/Cohen (tip flex)

- largest ETT tube/ 4cm above carina/ no final adjustments until in position

Thoracic Support:

Thoracic Case managers	5394
Theatre S	3115
Theatre T	3120
North Wing Recovery	3100

Lists available via Thoracic Case managers

Usually x 1 inpt max, remainder DoS TCI 0730

CPB:

Heparinisation prior to CPB:

- 300 units/kg Heparin, followed by ACT at 2 -3mins to check response. ACT >400 seconds is needed to safely go on to bypass.

Predicting Hb on CPB:

- (Gas Hb in g/dL x Blood volume (70mL x weight))/ (pt blood volume mL+ prime volume mL)

- STANDARD PRIME = ~1400mL clear fluid:

  - 5000iu heparin

  - 250-500mL CSL (lactate buffer)

  - 0.5g/kg mannitol 10% (400mL for 80kg)

  - 500mL gelofusine

Improving Hb on CPB:

- Aim 8-10g/dL
- Addition of Cell saver volume
- Bank blood
- Haemofiltration
- RAP (retrograde autologous prime)
- MECC (mini bypass)/ Small adult circuit
- MUF (modified ultrafiltration)

Checks when on Pump:

1. Propofol infusion increase
2. Products requested
3. Pacemaker available
4. Pressors ready/ drawn up

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5. Paperwork up to date (Metavision)

6. Premed prescribed for next patient

7. Perfusion Parameters (MAP >65-70/Hb/ NIRS/ ABG)

Coming off CPB:

CVS:

1. Fix SVR (phenyl/ NA infusion) + HR (pacing)

2. Assess response to filling (visual/Echo/CVC/BP)

3. Inotropy: (DA +/- Milrinone)

4. Mechanical: IABP +/- ECMO

5. Monitoring: PA catheter

Reversal of Heparin:

- 1mg Protamine per 100 units Heparin

1) Only give at the request of the surgeons

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2) Tell the perfusionist (‘Suckers off’)

3) Give slowly – as can cause significant haemodynamic instability

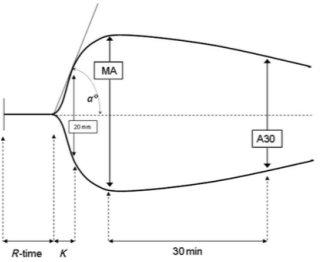
Clotting Targets (Don't treat if not bleeding):

1. Aim Hb 90-100g/L

2. Aim plts > 75

3. INR < 1.5 (Octaplex/ FFP)

4. R-time < 8-12mm on TEG

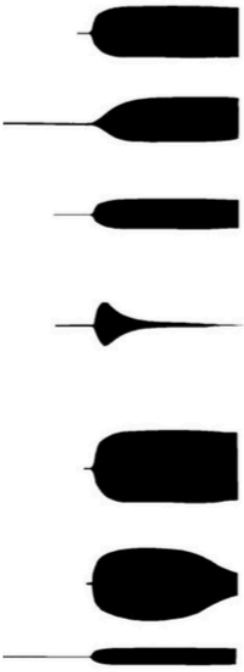


TEG Trace:

Ref: Curry ANG and Pierce JMT. Conventional and near patient tests of coagulation. CEACCP 2007)

Parameter	Normal range (Kaolin-activated sample)	Increased	Decreased
R-time	8-12mm	Anticoagulants Clotting factor deficiencies Severely low fibrinogen	Hyper-coagulable conditions
K-time	2-4mm	Anticoagulants Low Fibrinogen Low Platelets	High fibrinogen Increased platelet function
α-angle	66-77º	High fibrinogen Increased platelet function	Anticoagulants Low Fibrinogen Low Platelets
MA	60-75mm	Hyper-coagulable states High platelet count	Low Platelets Poor platelet function/platelet inhibitors Fibrinolysis Factor deficiencies (lesser extent)
LY30	<7.5%	Fibrinolysis e.g. t-PA given	Anti-fibrinolytics given e.g. TXA

Standard TEG Patterns:



TEG6s:

TEG6 machines allow the use of the following 2 cartridges:

- Global Haemostasis Cartridge (Blue top citrated specimen tube)
- Platelet Mapping Cartridge (Green top heparinised specimen tube)

Global Haemostasis

Test	Component tested	Parameter of interest	Deficiency/ Abnormality	Therapy
CK (Citrated Kaolin)	Clot formation rate	↑ R time	Clotting factors*	FFP/ FFP96(Octaplas)/ PCC (Octaplex)
CKH (Citrated Kaolin + Heparinase)	Clot formation rate without heparin effect	↓ R time (compared with CK-R time)	Heparin effect (if CKH-R time < CK-R time)	Protamine
CRT (Citrated Rapid TEG)	Clot strength due to Platelet and fibrin	↓ MA	Platelets (if CFF-MA normal)	Platelets
	Clot Stability due to fibrinolysis	↑ LY30	Fibrinolysis	Tranexamic Acid
CFF (Citrated Functional Fibrinogen)	Clot strength due to fibrin	↓ MA	Fibrinogen	Fibrinogen (Cryoprecipitate or Fibrinogen Concentrate)

* In the presence of Heparin (where CKH-R time < CK-R time), refer to CKH-R time for clotting factor adequacy.

‘Product’ Types:

Calcium gluconate 10%

Clotting factor IV. Chelated by citrate in blood products (including packed red cells, platelets, octaplas, and octaplex). Will typically require replacement post citrated blood/product transfusion. Also increases inotropy. Aim ionised Calcium (ABG) >1.15.

Cryoprecipitate

a source of fibrinogen, factor VIII and von Willibrand factor. 2 Pools should raise the patient’s fibrinogen level by approx 1 g/L

Fresh Frozen Plasma

The non-cellular component of blood. Contains factors II, V, VII, VIII, IX, X, XI, fibrinogen, proteins C and S, and ATIII. Takes approx. 30-40 minutes to defrost in the laboratory.

Novo 7 (rFVIIa)

Off-licence use

Octaplas (FFP96)

Pathogen-reduced FFP sourced from outside UK for patients born after 1 Jan 1996, in order to minimise the transmission of vCJD.

Octaplex (Prothrombin complex concentrate)

Prothrombin Complex Concentrate = vitamin K-derived clotting factors (II, VII, IX, X) in a small volume (compared with plasma transfusion).

Platelets

2 hr turnaround. One pool typically raises count by 30 $x10^9$/L.

Tranexamic Acid

An antifibrinolytic, which prevents clot lysis.

Ch. 3 - Echocardiography Intraoperative TOE Guide:

1. Turn on TOE machine
2. Input patient details
3. Connect ECG

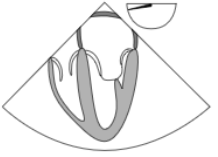
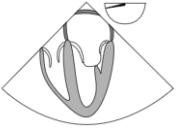
Include the minimum dataset **for all**

4. Follow algorithms (see following pages):
    a. General Overview + LV/RV
    b. AVR – structural/doppler views
    c. MVR – Usually MR +/-TVA/LAAO
    d. LAAO +/- other structures

Adapted from: Wheeler R et al. 2015. A minimum dataset for a standard transoesophageal echocardiogram: a guideline protocol from the British Society of Echocardiography. Echo Research and practice. Dec 1;2(4):G29-45

Notes – These guides are NOT comprehensive. Each algorithm designed to cover structure for a 'quick' procedure om the setting of adult acquired disease. If further investigation/ details required, to undertake further measurements.

General Overview:

Image (2D):	**Reference:**
	
	<u>Territories:</u>
	1. Pull back probe slightly 2. LVOT/ Mitral CFD (same time if rush) 3. Orientate AV to centre of view 4. Omniplane angle -> 50° for AV SAX (see AVR protocol)…

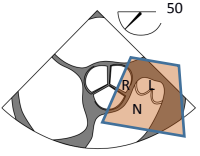
'AVR Protocol' (if AS/AR main problem)

'LV/RV protocol' if IHD

'MV protocol' (if MR/MS) main problem **+/- TVA +/- LAAO**

AVR Protocol (Structural Views):

Image (2D): **Aims/Re**



1. Inspect leaflets

(movement, thickening, calcium)

2. Co number cusps

Tri/Quad

120

3. Planimetry

mid-systole for AVA

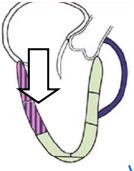
4. CFD

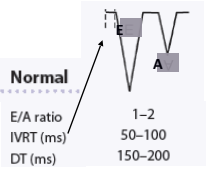
ANT

SEPT

Any Regurgitation, where?

INF LAT

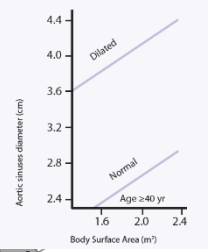




(Mid-syst
0.5-1cm from
valve orifice

- Annulus
- Sinus
- STJ
-Asc Aorta

Mid-syst



ARR?

> 5.5cm or > 5.0cm if syndrome

> 4.5cm if other surgery

OR..

Dimensionless Index (Similar to Velocity ratio):

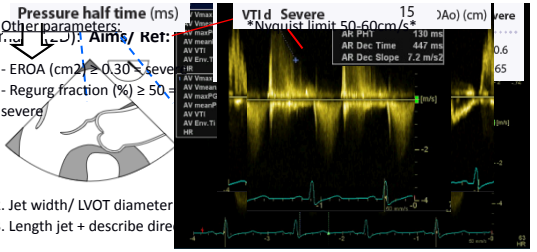
- VTI LVOT / VTI AV (< 0.25 = severe)

Image (2D):	Aims/ Ref:
	
	
	

	Normal	Mild	Moderate	Severe
LV wall thickness				
IVSd / PWd (cm)	0.6–1.2	1.3–1.5	1.6–1.9	≥2.0
LV dimension, women				
LVIDd (cm)	3.9–5.3	5.4–5.7	5.8–6.1	≥6.2
LVIDd / BSA (cm/m²)	2.4–3.2	3.3–3.4	3.5–3.7	≥3.8
LV dimension, men				
LVIDd (cm)	4.2–5.9	6.0–6.3	6.4–6.8	≥6.9
LVIDd / BSA (cm/m²)	2.2–3.1	3.2–3.4	3.5–3.6	≥3.7
LV function				
Fractional shortening (%)	25–43	20–24	15–19	<15
Ejection fraction (%) EF by Biplane Simpson's method*	≥55	45–54	36–44	≤35

AVR Protocol (AS doppler views): AVR Protocol (AR doppler views):

	Mild	Moderate	Severe
Peak velocity (m/s)	<2.9	3.0–3.9	>4.0
Mean pressure drop (mmHg)	<25	25–40	>40
Valve area (cm²)	1.5–2.0	1.0–1.4	<1.0
Velocity ratio (m/s)	≥0.5	0.25–0.5	≤0.25

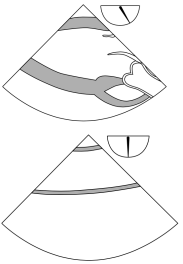


Other parameters:

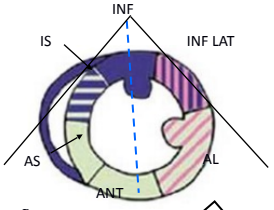
Ir... (LVD): **Aims/ Ref:**

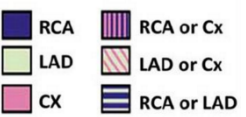
- EROA (cm2) ≥ 0.30 = seve
- Regurg fraction (%) ≥ 50 = severe

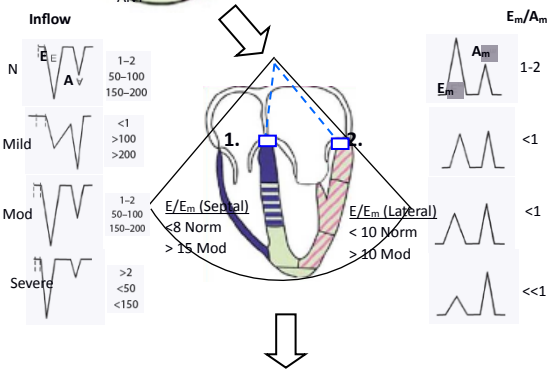
2. Jet width/ LVOT diameter
3. Length jet + describe dire

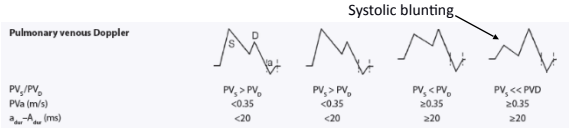


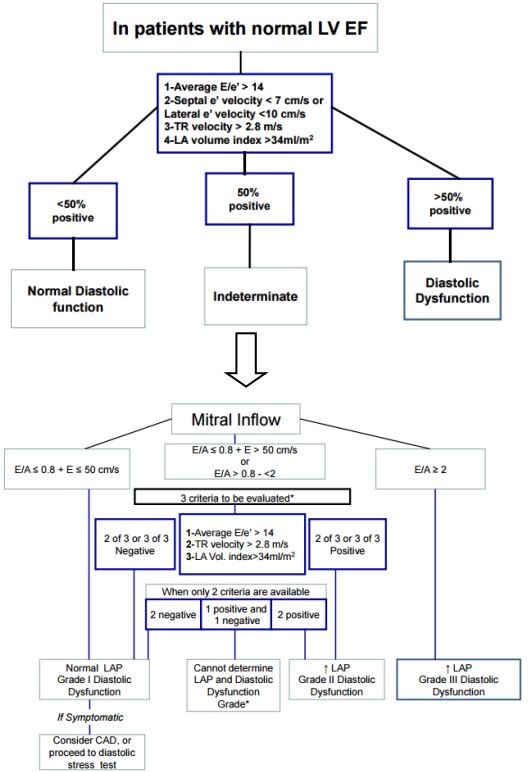
LV Assessment:





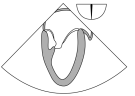






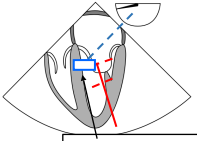
(* : LAP indeterminate if only 1 of 3 parameters available. Pulmonary vein S/D ratio <1 applicable to conclude elevated LAP in patients with depressed LV EF)

Mitral valve Protocol 1 (2D Views):

Angle:	Tips:	Image (2D):
ME 0	- Annulus/leaflet morphology/leaflet motion/Sub-valvular apparatus - Pathology - A1/P1 (Withdrawal/anteflexion) - A3/P3 (Insertion/retroflexion) - Commissure (anterolateral)	
ME 60	- Assess P3/A2/P1 - Major axis dimension (end diastole and end systole) - Visual inspection of MR/MS	
ME 90	- Assess P3/A3,A2,A1 - commissure (posteriomedial) - Visual inspection of MR/MS	
ME 120	- Minor axis dimension (end diastole and end systole) - Visual inspection of MR/MS	
TG 0	- A1,A2, A3 Bottom to top - P1,P2,P3 Bottom to top	

MV Protocol 2 (RV +/- TVA):

Image (2D): **Aims:**



- **RV size (End diastole):**

TAPSE > 16 mm

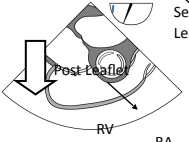
- @base <
- @m point <3.5
- le <8.6cm

50

Post Leaflet

- Tricuspid Valve :

- Leaflets (Ant/ Sept)
- Annulus size (EDD + ESD):



120

PA pressures	Mild	Moderate	Severe
Peak velocity (m/s)	<3	3–4	>4

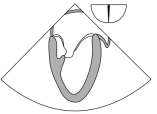
- **CFD TR**: Mild <1cm/narrow jet, severe = wide/large jet
- **CW jet**: soft/slow = mild, dense/variable = intermed, dense/steep = severe

Sept or Ant Leaflet

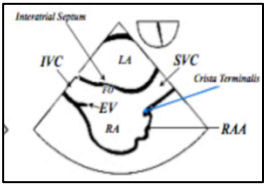
(TG RV Inflow)

VC width (cm)	Not defined	<0.7	>0.7
PISA radius (cm)	<0.5	0.6–0.9	>0.9
CW jet density/contour	Soft/ parabolic	Dense/ variable	Dense/ triangular early peaking

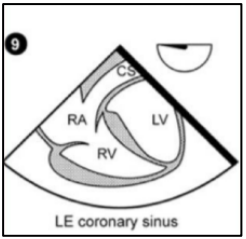
LAAO:

LAA Types/ Morphology:			
ME 2Ch (90)	2D		- LAA assessment (in at least 2 planes). - Assess the extent of LAA cavity + Emptying velocities
ME LAA (60-130)	2D CFD PW		- PW to prox 1/3rd - Clot assoc with velocities < 20cm/s - Assess 'coumarin ridge' - Off CPB confirm clip/occlusion device

Other Structures:



Eustachian Valve (left) +
Crista Terminalis (Right)



Coronary Sinus:
- Normal 12mm +/-2mm
- > 15mmHg, suspect PAPVD

Prosthetic Aortic valves at UHS:

Pericardial Valves with leaflets inside the stent:

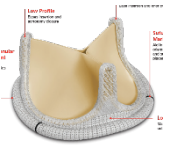
1. **Perimount - Carpentier-Edwards**

- Bovine pericardial leaflets
- CoCr alloy stent
- Polyester cloth, silicone rubber sewing ring
- 19mm – 29mm sizes (odds)
- Variant = Magna valve (23% greater EOA)

	Gradient	19 mm	21 mm	23 mm	25 mm	27 mm	29 mm
Perimount	Peak	32.5±8.5	24.9±7.7	19.9±7.4	16.5±7.8	12.8±5.4	N/A
	Mean	19.5±5.5	13.8±4.0	11.5±3.9	10.7±3.8	4.8±2.2	N/A

2. Perimount Magna Ease – Carpentier-Edwards

- Lower profile: eases insertion + aortotomy closure
- Supra-annular design (optimal haemodynamics)
- Sleek commissure posts (ease insertion/knot tying)
- Suture markers (orientation + suture placement)
- Low Stent Base (coronary ostia clearance)



Pericardial Valves with leaflets outside the stent:

1. Crown PRT – Sorin

- Bovine pericardial layer mounted outside stent

- Flat profile (lower knots and coronary clearance)

2. Trifecta -St Jude

- 'Linx AC technology' (anti-calcification)
- Tissue bovine leaflets
- Titanium alloy stent

Composite:

1. BioIntegral

- Composite root conduit with porcine valve

Mechanical bileaflet:

1. **MCRI On-X (Aortic shown)**

- PTFE Sewing ring
- Pyrolytic carbon coating
- Leaflet guards, 'flared' inlet + Actuated pivot design (90˚ opening)
- Lower INR 1.5-2 (longterm mgt only)
- Most commonly used in UHS

	Gradient	19mm	21 mm	23 mm	25 mm
On-X (Aortic)	Peak	21.3±10.8	16.4±5.9	15.9±6.4	16.5±10.2
	Mean	11.8±3.4	9.9±3.6	8.6±3.4	6.9±4.3
	EOA(cm^2)	1.5±0.2	1.7±0.4	1.9±0.6	2.4±0.6

---

2. **Carbomedics Top Hat – Sorin**

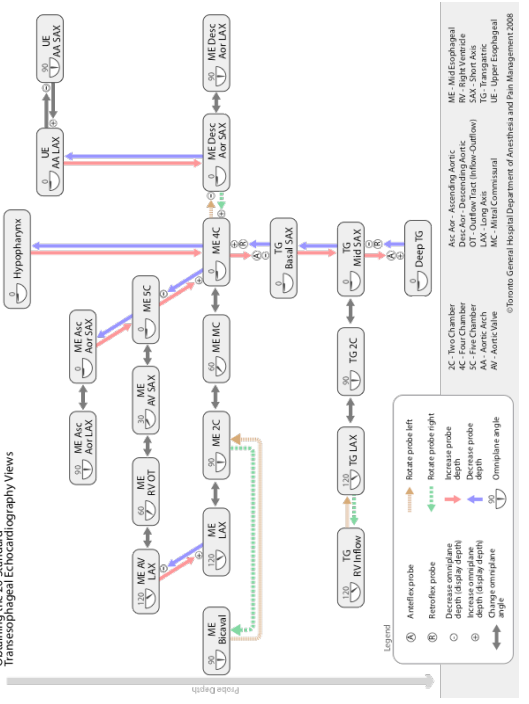
- Supra-annular aortic valve with good haemodynamics
- Alternative to aortic enlargement

	Gradient	21 mm	23 mm	25 mm
Toph at	Peak	30.2± 10.9	24.2± 7.6	NA
	Mean	14.9± 5.4	12.5± 4.4	9.5±2. 9
	$EOA_{(cm^2)}$	1.2±0. 3	1.4±0. 4	1.6±0. 32

Data adapted from EchoCalc. British Society of Echocardiography. 2015. Available at https://itunes.apple.com/gb/app/echocalc/id468166426?mt=8

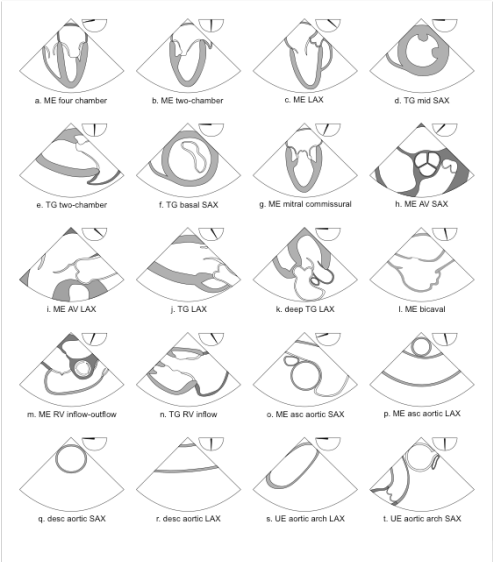
TOE: Map of views

Toronto General Hospital Department of Anaesthesia and Pain Medicine. 2008. Available at http://pie.med.utoronto.ca/TEE/TEE_content/assets/PDF/TEE-help-sheet-100910-high.pdf



20 Standard TOE views

From Shanwise J et al. ASE/SCA guidelines for performing a comprehensive intraoperative multiplane transesophageal echocardiography examination: recommendations of the American Society of Echocardiography Council for Intraoperative Echocardiography and the Society of Cardiovascular Anesthesiologists Task Force for Certification in Perioperative Transesophageal Echocardiography. *Anesth Analg* 1999;89:870–884



Southampton CICU Focused TOE

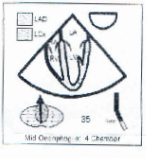
The aim of the focused TOE exam is to identify serious pathology using 8 views to enable initiation of appropriate management

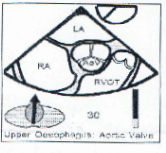
Life-threatening pathology

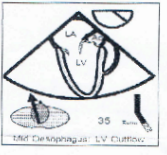
1. Left Ventricular hypovolaemia
2. Left Ventricular systolic failure
3. Right Ventricular failure
4. Massive PE
5. Pericardial tamponade
6. Severe Aortic valve stenosis
7. Aortic dissection

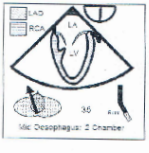
Secondary pathology

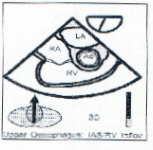
1. Examine for regional wall motion pathology
2. Ventricular wall and cavity dimensions
3. Tricuspid regurgitation and estimate PA pressure
4. Aortic valve disease
5. Severe Mitral valve disease
6. Assess position of CVC, PAFC, IABP
6. Presence of pleural effusion

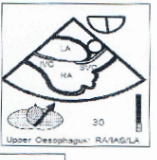


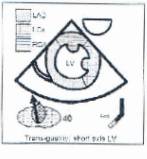


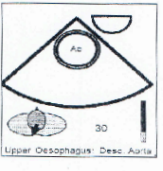












Version 1.1 May 2015 PD/KW – Based on St George's FIT scan by Fletcher/Edsell/Leech

Chamber and function quantification

(Ref: Masani et al. British Society of Echocardiography Education Committee. Echocardiography: guidelines for chamber quantification. G407. British Heart foundation. 2011. Available at: https://www.bhf.org.uk/publications/tests-for-heart-conditions/echocardiography-guidelines-for-chamber-quantification-poster) Note: The following tables are based on TTE imaging.

Left atrial size

	Normal	Mild	Moderate	Severe
LA size, women				
LA diameter (cm)	2.7–3.8	3.9–4.2	4.3–4.6	≥4.7
LA volume (ml)	22–52	53–62	63–72	≥73
LA size, men				
LA diameter (cm)	3.0–4.0	4.1–4.6	4.7–5.2	≥5.3
LA volume (ml)	18–58	59-68	69–78	≥79
LA size, index				
LA diameter (cm/m^2)	1.5–2.3	2.4–2.6	2.7–2.9	≥3.0
LA volume (ml/m^2)	16–28	29–33	34–39	≥40

Tricuspid regurgitation

	Mild	Moderate	Severe
Jet area (cm^2)	<5	5–10	>10
VC width (cm)	Not defined	<0.7	>0.7
PISA radius (cm)	<0.5	0.6–0.9	>0.9
CW jet density/contour	Soft/ parabolic	Dense/ variable	Dense/ triangular early peaking
RA/RV/IVC size	Normal	Normal/dilated	Usually dilated
Hepatic vein flow	Systolic dominance	Systolic blunting	Systolic reversal

Left Ventricular size and function

	Normal	Mild	Moderate	Severe
LV wall thickness				
IVSd / PWd (cm)	0.6–1.2	1.3–1.5	1.6–1.9	≥2.0
LV dimension, women				
LVIDd (cm)	3.9–5.3	5.4–5.7	5.8–6.1	≥6.2
LVIDd / BSA (cm/m²)	2.4–3.2	3.3–3.4	3.5–3.7	≥3.8
LV dimension, men				
LVIDd (cm)	4.2–5.9	6.0–6.3	6.4–6.8	≥6.9
LVIDd / BSA (cm/m²)	2.2–3.1	3.2–3.4	3.5–3.6	≥3.7
LV volume, women				
LV diastolic volume (ml)	56–104	105–117	118–130	≥131
LV systolic volume (ml)	19–49	50–59	60–69	≥70
LV volume, men				
LV diastolic volume (ml)	67–155	156–178	179–201	≥202
LV systolic volume (ml)	22–58	59–70	71–82	≥83
LV volume index				
LV diastolic volume/BSA (ml/m²)	35–75	76–86	87–96	≥97
LV systolic volume/BSA (ml/m²)	12–30	31–36	37–42	≥43
LV function				
Fractional shortening (%)	25–43	20–24	15–19	<15
Ejection fraction (%) EF by Biplane Simpson's method*	≥55	45–54	36–44	≤35
LV mass, women				
LV mass (g)	66–150	151–171	172–182	>182
LV mass / BSA (g/m²)	44–88	89–100	101–112	>112
LV mass, men				
LV mass (g)	96–200	201–227	228–254	>254
LV mass / BSA (g/m²)	50–102	103–116	117–130	>130

Tricuspid stenosis

	Normal	Severe
Mean pressure drop (mmHg)	-	≥5
Inflow velocity-time integral (cm)		>60
Valve area (cm²)	>7.0	<1.0

Normal	3.0-4.0		1.4-2.2	8-20			
Mild	>1.5	>0.85	2.6-2.9	20-40	<20	<30	
Mod	1.0-1.5	0.6-0.85	3.0-4.0	40-70	20-40	30-50	
Severe	**< 1.0**	**<0.6**	**>4.0**	**>70**	**>40**	**>50**	

(ref: Vegas, A. Perioperative Two-Dimensional TOE. Adapted from: Baumgartner H et al. J Am Soc Echocardiogr 2009;22:1-23.)
(ref: Vegas, A. Perioperative Two-Dimensional TOE. Adapted from: Zoghbi W et al. J Am Soc Echocardiogr 2003;16;777-802.)

Aortic Regurgitation (reference):

Method	Mild	Moderate	Severe
Jet/LVOT width*	<25%	25-64%	>65%
PHT (ms)	>500	500-200	<200
Descending Ao Reversal	Early brief	Intermediate	Holodiastoli
Vena Contracta* (mm)	<3	3-6	>6
ERO area (cm^2)	<0.10	0.1-0.29	>0.3

Requrgitant Volume (cc)	<30	30-59	>60
Regurgitant Fraction (%)	20-30	30-49	>50
* Nyquist limit 50-60 cm/s			

Right ventricular size and function

	Abnormal
RV dimensions (apical 4 chamber)	
Basal RV diameter (RVD1) (cm)	>4.2
Mid RV diameter (RVD2) (cm)	>3.5
Base to apex length (RVD3) (cm)	>8.6
RVOT diameters (parasternal SAX)	
RVOT at AV level (RVOT1) (cm)	>3.5
RVOT at PV annulus (RVOT2) (cm)	>2.7
PA diameter (parasternal SAX)	
Main PA (PA1) (cm)	>2.2
RV area	
RV diastolic area (cm^2)	>25
RV systolic area (cm^2)	>14
RV function	
Fractional area change (%)	>35
TAPSE	>16

Right atrial pressure

	0–5mmHg	5–10	10–15	15–20	>20
IVC					
size (cm)	<1.5	1.5–2.5	1.5–2.5	>2.5	>2.5
Respiratory/sniff variation	collapse	↓ >50%	↓ <50%	↓<50%	No change
Other					
RA size	normal	normal	↑	↑↑	↑↑
Hepatic vein size				↑	↑↑

Mitral Stenosis:

(EAE/ASA Guidelines)

	Valve area (cm^2)	Mean gradient (mmHg)	PHT (msec)	Peak pulmonary artery P (mmHg)
Normal	4-6		40-70	20-30
Mild	>1.5	<5	70-150	<30
Mod	1.0-1.5	5-10	150-200	30-50
Severe	< 1.0	>10	>220	>50

(ref: Vegas, A. Perioperative Two-Dimensional TOE. Adapted from: Baumgartner H, et al. J Am Soc Echocardiogr 2009;22:1-23)

Mitral Regurgitation

Method	Mild	Moderate	Severe
CW Doppler signal strength	Faint	Mod	Dense
Jet area mapping (cm^2)*	<4	4-10	>10
Pulmonary venous Doppler (S wave)	Normal	Blunted	Reversed
Vena Contracta* (mm)	<3	3-6	7+
ERO area (cm^2)	<0.2	0.2-0.39	>0.4
PISA radius (mm) (Nyquist at 40cm/s)	<4	4-9	>10
Regurgitant Fraction (%)	<30	30-49	50+
* Nyquist limit 50-60 cm/s			

(ref: Vegas, A. Perioperative Two-Dimensional TOE. Adapted from: Zoghbi W et al. J Am Soc Echocardiogr 2003;16;777-802.)

Left ventricular diastolic function

(deflections based on TTE acquisition)

	Normal	Mild	Moderate	Severe
		↓Relaxation	↓ Relaxation ↑ Compliance ↑LVEDP	↓ Relaxation ↑ Compliance ↑↑ LVEDP
		Abnormal relaxation	Pseudo-Normal	Restrictive filling
LV inflow Doppler				
E/A ratio	1–2	<1	1–2	>2
IVRT (ms)	50–100	>100	50–100	<50
DT (ms)	150–200	>200	150–200	<150
Pulmonary venous Doppler				
PV_s/PV_D	$PV_s > PV_D$	$PV_s > PV_D$	$PV_s < PV_D$	$PV_s << PVD$
PVa (m/s)	<0.35	<0.35	≥0.35	≥0.35
$a_{dur}–A_{dur}$ (ms)	<20	<20	≥20	≥20
Mitral annular tissue Doppler				
E_m/A_m	1–2	<1	<1	<<1
E/E_m (average)	<8	-	-	>13

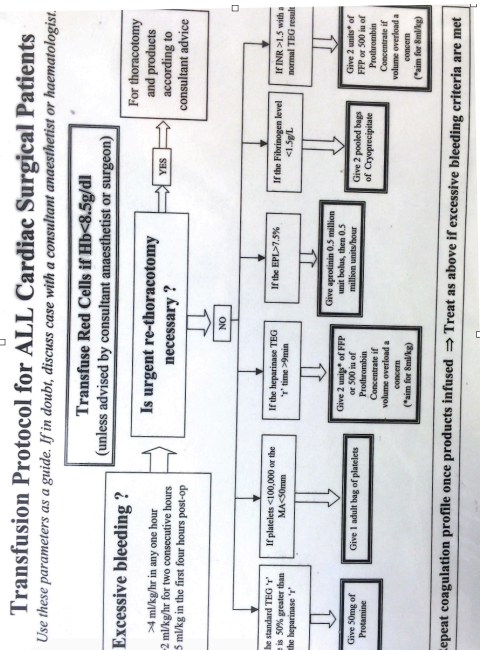
Pulmonary regurgitation

	Mild	Moderate	Severe
Jet size (CFM) (cm)	Narrow, <1.0	Intermediate	Wide, large
Regurgitant fraction (%)	<40	40–60	>60
CW jet density/deceleration rate	Soft/slow	Dense/variable	Dense/steep
$RVOT_{VTI}$ / $LVOT_{VTI}$	↑	↑↑	↑↑↑

Ch. 4 - Postoperative:

Bleeding/ Clotting/ ICU Care

Cardiac Transfusion Protocol



Haemofiltration:

Dose: 35ml/kg/hr or > 25ml/kg/hr sufficient for most. Higher volumes may reduce vasopressor requirements, but increase electrolyte disturbances.

No evidence for actual vs ideal weight

CRRT achieves ~ 25-50mL/min Cr Cl

Replacement fluids (prescribe):

- Hemosol BO

- Prismasol 4

Anticoagulation:

1. Heparin. Usually avoid giving heparin bolus to patient. Just start infusion. Aim aPTT 1.5-2.0

2. In people with heparin-induced thrombocytopenia, consider using:

A. Epoprostenol

Compatible with 0.9% saline only

Dose: 1-5nanograms/kg/min

Preparation: Make up a concentration of 2mcg/ml (100mcg in 50ml syringe). Run at:

Patient Weight (kg)	ml/h [4ng/kg/min]	ml/h [5ng/kg/min]
50	6.0	7.5
60	7.2	9.0
70	8.4	10.5
80	9.6	12.0
90	10.8	13.5
100	12	15.0

Note: 2mcg/kg diluted syringes are only stable for 12h in the fridge.

B. Argatroban (direct thrombin inhibitor IV prep) = licensed

- No IV bolus

- Infusion 2mcg/kg/min -> Rpt aPTT 4hr dose adjustment

- Monitor APTT (1.5-3)

- Hepatic metabolism (Liver Failure 0.5mcg/kg/min start)

C. Heparinoids (Danaparoid IV prep) = licensed

- Indirect Anti Xa +/- little thrombin

- 24 half life

- Min effect on aPTT/ None on PT

- Monitor with AntiXa Assay if Renal Failure

- 750 units BD or TDS **prophylaxis*

- 1250 – 3750 units bolus IV then 400units/hr infusion for 4 hrs, then 300/hr for 4 hrs, then 150-200 units/hr maintenance IV **Treatment*

D. Citrate regional

- Remember, separate DVT prophylaxis required.

- Just started using in CICU..

E. Fondaparinux (not licensed)

F. Bivalirudin (not licensed)

G. Lepirudin (not licensed/ available at UHS)

Low Cardiac Output State:

Monitoring:

Cardiac output = SV x HR	(4 – 8 L/min)
CI = CO / BSA	(< 2, 2 – 2.5, > 2.5 L/min/m2)
PAWP ≤ 15mmHg	

Causes:

Poor LV, preload, high afterload, rhythm + rate (Physiology)
Air embolism / tamponade +/- bleeding
Stunning
Perioperative MI
Incomplete revascularisation/ graft kinking
PHTN
Other: SAM (MV repairs), drug reaction, HOCM, vasoplegia

Support for Low CO/ ECMO:

- Inotropes, IABP, ECMO

- ECMO maintenance (mainly on CICU):

HCT 40-45%
Plts > 80
ACT 180-240
Low TV IPPV < 5mL/Kg

New dose for ECMO cannulation **75iu/kg**
If >30mins until on ECMO, repeat ACT and give extra 25iu/kg if ACT<300

Air entrainment (*Emergency*):

Diagnose cause/ site + purge pump + circuit

1. Clamp arterial line
2. Clamp venous line
3. stop pump
4. Run cystalloid into circuit + drain/ purge
5. manipulate pump head to encourage air towards oxygenator
6. Once air drained -> close tubing to bag + open AV bridge, inspect for air

Pulmonary HTN:

Normal PAP:

PAP	<25/10mmHg
PAPm	14 ± 3mmHg (< 20mmHg)

pHTN:

Pre-capillary PH	PAPm ≥ 25mmHg PAWP ≤ 15mmHg
Post-capillary PH	PAPm ≥ 25mmHg PAWP > 15mmHg

Classification complicated and many different subsets of disease with specific management – seek advice.

Classification (Non-congenital):

1. PAH (idiopathic vs assoc with syst disease)
2. PAH due to left heart disease
3. PAH due to lung diseases/hypoxia
4. Obstructive/ thromboembolic
5. PH unclear or multifactorial mechanisms

ICU Treatment (Seek expert advice!):

A) Maintain patient's normal therapy where possible
B) Maintain PAPm 25mmHg < Systemic MAP
C) For rising PAPs, add in:

1. **NO:** 5-25 ppm via Noxbox
2. **Prostanoids:**

- Iloprost nebs (20mcg 3 hrly)
- Iloprost IV (50mcg in 250mL 5% dextrose)
- 0.5-2mcg/kg/min (approx. 12-48mL/hour).
- Increase dose ½ hourly

3. **Vasodilators - PDE Type 5 inhibitors:**
   - Sildanefil po/NG (20mg TDS, increase up to 50mg)
4. **Endothelin receptor antagonists:**
   - Ambrisentan po/NG (5mg od, increased to 10mg od)
   - N.B. Liver metabolised
4**. Surgical/ Cardiology Intervention:**

- Balloon atrial septostomy > failure max med therapy
- +/- lung transplantation

Heparin-induced thrombocytopenia

4T's assessment point system

Category	2 points	1 point	0 points
Thrombo-cytopenia	>50% fall or Nadir of 20-100 x 10^9/L	30% - 50% fall or Nadir of 10-19x 10^9/L	<30% fall or Nadir of < 10 x 10^9/L
Timing of fall	Days 5 – 10 or less than or equal 1 day if there is heparin exposure within the past 30 days.	Greater than day 10 or unclear or less than 1 day if heparin exposure within past 30 – 100 days	Less than or equal to 1 day with no recent heparin therapy
Thrombosis (or other sequelae)	Proven thrombosis, skin necrosis, or other heparin bo-lus, acute systemic reaction	Progressive, recurrent, or silent thrombosis; erythematous skin lesions	None
Other causes	None evident	Possible	Definite

Score	0-3	Low probability	
	4-5	Intermediate probability	
	6-8	High probability	

Steele J, Kadosh B, Gulkarov IM, Salemi A (2011) Heparin Induced Thrombocytopenia and Cardiac Surgery: A Comprehensive Review. J Blood Disord Transfus S2:003.

Ch. 5 – Congenital information

A classification of congenital lesions

1. 'Simple' left-to-right shunt (Qp > Qs), with increased pulmonary blood flow

Atrial septal defect

Ventricular septal defect

Atrio-ventricular septal defect

Patent ductus arteriosus

Aorto-pulmonary window

A large VSD or AVSD can demonstrate more complex balancing between Qp:Qs.

A large reduction in SVR, or a pulmonary hypertensive crisis are two examples that cause a left-to-right (Qp>Qs) shunt to reverse to a right-to-left shunt (Qp<Qs), resulting in cyanosis.

2. ‘Simple’ right-to-left shunt (Qp<Qs), with decreased pulmonary blood flow & cyanosis

Tetralogy of Fallot

Pulmonary atresia

Tricuspid atresia

Ebstein’s anomaly

3. ‘Complex’ shunts, with complex mixing of pulmonary and systemic blood, and thus a complex interplay between pulmonary (Qp) and systemic (Qs) blood flow

Examples of parallel circulations are marked with an *

Transposition of the great arteries*

Truncus arteriosus*

Double-outlet right ventricle*

Hypoplastic left heart syndrome*

Presence of a BT shunt*

Total anomalous pulmonary venous drainage

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4. Obstructive lesions

Coarctation of the aorta

Interrupted aortic arch

Pulmonary or aortic stenosis

Qp:Qs

the ratio of pulmonary to systemic blood flow

Simplified shunt calculation

$$\text{Qp}:\text{Qs} = \frac{(S_{sa}O_2 - S_{mv}O_2)}{(S_{pv}O_2 - S_{pa}O_2)}$$

S = saturation, sa = systemic arterial, mv = mixed venous, pv = pulmonary vein, pa = pulmonary artery

Note: In the presence of a shunt, $S_{mv}O_2 \neq S_{pa}O2$

Formula for estimating mixed venous Sats when calculating a shunt:

In adults: $S_{mv} = \frac{(3S_{SVC} + S_{IVC})}{4}$

In infants/children: consider accepting $S_{mv} \equiv S_{SVC}$

For a univentricular heart with only aortic-pulmonary blood flow

$$\mathrm{Qp:Qs} = \frac{(S_{sa}O_2 - S_{mv}O_2)}{(S_{pv}O_2 - S_{sa}O_2)}$$

Inter-atrial shunts: Qp:Qs is dependent primarily on the compliance differences between the two ventricles.

Inter-ventricular or great vessel level shunts: Qp:Qs is dependent primarily on the relative resistances of the pulmonary and systemic circulations. Manipulation strategies include:

To increase pulmonary blood flow: Reduce PVR (+/- increase SVR)

To decrease pulmonary blood flow: Increase PVR (+/- decrease SVR)

Factors increasing PVR

Hypoxia

Hypercarbia

Acidosis

Hypothermia

Sympathetic stimulation or catecholamines

Low or high lung volumes, or atelectasis or hyperinflation respectively

High airway pressures

Factors decreasing PVR

Increasing FiO_2

Decreasing $PaCO_2$

Alkalosis

Avoidance of hypothermia

Pulmonary vasodilators (iNO, Milrinone, Sildenafil)

Avoidance of catecholamine surges (pain, sympathetic stimulation)

Lung volume at functional residual capacity

A Possible circulatory troubleshooting strategy post Norwood based on S_VO_2:

S_aO_2	S_vO_2	$Q_P:Q_S$	Suggested intervention
80	60	1	None; wean support slowly
80	40	2	Deepen sedation/warmth/vasodilator
70	50	0.67	Resolve atelectasis, raise SVR
70	40	1	Raise cardiac output, raise Hb, reduce O_2 consumption
70	20	2	Raise cardiac output, lower SVR
60	40	0.5	Resolve atelectasis, raise SVR, consider iNO, consider shunt augmentation
87	70	1.5	Wean support
87	40	3.6	Deepen sedation, vasodilation, consider shunt restriction

Troubleshooting differential diagnosis post SCPA/Glenn

Status	PAP	LAP	TPG	S_pO_2	Aetiology
Normal	10-15	2-6	<10	80±5	Ideal
Elevated PAP	>15	2-6	>10	<75	High PVR; PA or PV obstruction
Elevated LAP	>15	>8	<10	<75	Ventricular dysfunction, sub-AS, AVVR, tamponade
Cyanosis	10-15	2-6	<10	<75	Decreased cerebral blood flow; PV desaturation, decompressing veins; hypovolaemia, anaemia

Status	PAP	LAP	TPG	SpO2	BP sys	Aetiology
Normal	10-15	2-6	<10	95±5	85-95	Ideal
Decreased PAP and LAP	8-10	0-4	<10	90±5	<80	Hypovolaemia
Elevated PAP	>15	2-6	>10	90±5	80±5	High PVR; PA or PV obstruction
Elevated LAP	>15	>8	<10	90±5	80±5	Ventricular dysfunction, AV dissociation, AVVR, tamponade
Cyanosis	10-15	2-6	<10	<85	85-95	Excessive fenestration size or Fontan baffle leak; PV desaturation; decompressing veins; hypovolaemia; anaemia

Troubleshooting differential diagnosis post Fontan

Congenital heart disease – An introductory glossary of terms

Anomalous pulmonary venous drainage: partial - at least one, but not all, pulmonary veins connect to the right heart, often via the superior or inferior vena cava, leading to varying degrees of left-to-right shunt (Qp:Qs>1). **Total** - all pulmonary veins abnormally drain to the heart. Types include: supracardiac – where they eventually drain to the SVC, intracardiac – where they drain through the coronary sinus, and infracardiac – where they drain beneath the diaphragm to the portal venous system.

Aortopulmonary window: a window (communication) between aorta and main or right pulmonary artery. May be associated with interrupted aortic arch.

Atrial septal defect: types include patent foramen ovale (PFO), secundum, primum (a type of AV defect), sinus venosus (superior: at SVC to RA junction, associated with PAPVD of right upper and middle PVs; inferior: at IVC to RA junction, associated with PAPVD right lower PV), coronary sinus (unroofed coronary sinus leading to communication between left atrium and coronary sinus). Leads to left-to-right shunt.

AVSD: atrio-ventricular septal defect due to incomplete fusion of the endocardial cushions, leading to malformation of the mitral and tricuspid valves, atrial and ventricular septal defects. A common atrioventricular valve straddles the ventricular septum.

Balanced circulation: equal pulmonary and systemic blood flow (Qp:Qs = 1).

Bidirectional Glenn/bidirectional cavopulmonary shunt/superior cavopulmonary shunt (SCPC)/hemi-Fontan: SVC disconnected from RA and anastomosed to PA, causing pulmonary blood flow to comprise SVC venous blood. It is bidirectional because SVC blood is free to flow through either right or left PA (in contrast to a unidirectional/original Glenn shunt where the SVC was directly anastomosed to the right PA that had been disconnected from the main PA, thereby preventing SVC blood from flowing to the left PA).

Blalock-Taussig (-Thomas) shunt (BT shunt): original - transection of subclavian artery and end-to-side anastomosis to ipsilateral pulmonary artery. **Modified** - a graft conduit placed between either the innominate or subclavian artery and the ipsilateral pulmonary artery. Designed to allow some pulmonary blood flow through a systemic-to-pulmonary connection.

Brom repair: a 3-patch technique that allows repair of supra-aortic narrowing with enlargement of all 3 sinuses.

Carpentier's procedure: a method for tricuspid valve repair of Ebstein's anomaly, characterised by mobilisation of anterior leaflet, vertical plication of the atrialised RV, advancement of the anterior leaflet across the plicated area to reduce orifice size, and insertion of an annular ring for additional valve strength.

Central shunt: small tubular connection created between ascending aorta and main pulmonary artery. Designed to provide some pulmonary blood flow through a systemic-to-pulmonary connection.

Coarctation of the aorta: a narrowing of the thoracic aorta, usually distal to the left subclavian artery. Associated with bicuspid aortic valve.

Cone procedure/reconstruction: a method for tricuspid valve repair of Ebstein's anomaly, characterised by mobilisation of valve leaflets, maximisation of leaflet tissue through delamination of the valve tissue from the myocardium whilst maintaining chordae attachment, rotation and suturing of the leaflet complex to create a cone with base at the TV annulus and vertex in the right ventricular apex, and plication of atrialised RV.

Cor triatriatum: a restrictive membrane in the left atrium, dividing the atrium into two chambers. Blood from the upper chamber, where the pulmonary veins enter, drains into the lower chamber through one or more orifices in the membrane, with symptoms dependent on the degree of restriction through the membrane.

Damus-Kaye-Stansel operation: a proximal PA to aorta anastomosis (above their respective valves). It provides systemic flow in situations where there is LVOT obstruction or subaortic stenosis in functional univertricular hearts. Usually combined with either a BT shunt or a RV-PA conduit, which supplies pulmonary blood flow.

Double inlet left ventricle: both atria drain into a single ventricle, which is commonly connected to an additional hypoplastic ventricle via a bulboventricular foramen. The most common subtype is a double-inlet LV, which is anatomically right-sided, and has ventricular-arterial discordance (TGA).

Double outlet right ventricle: a defect in which both pulmonary artery and aorta arise from the right ventricle. A VSD is present, positioned either in a sub-pulmonary, sub-aortic, doubly-committed, or remote location. The resultant physiology can mimic that of tetralogy of Fallot, transposition of the great arteries, or a VSD, depending on the relation between the position of the VSD to the great arteries.

Ebstein's anomaly: abnormality of the tricuspid valve resulting in abnormal downward and rotational displacement of the valve orifice into the RV, with

atrialised portion of the RV between the annulus and abnormal leaflet attachments.

Fontan operation/Fontan completion/total cavopulmonary connection (TCPC): final stage in univentricular palliation (after a previous Glenn/SCPC/ hemi-Fontan procedure. The IVC is connected to the PA in one of 3 ways; originally through a RA-PA direct anastomosis, or through a lateral tunnel within the RA, or through an extra-cardiac conduit (now most common approach). A fenestration between the IVC and RA may be created to provide a right-to-left 'pop-off' pathway from the cavopulmonary circuit to the heart in order to lower the pressure in the circuit, albeit at the expense of lower saturations.

Heterotaxy: a complex syndrome of malformation, due to abnormal sidedness of thoracic and abdominal organs. Potential abnormalities include atrial or lung isomerism, single ventricle, poly- or a-splenia, bilateral or persistent left SVC, TAPVD, left-sided or interrupted IVC, and intestinal malrotation.

Holmes heart: a specific sub-type of DILV, with a hypoplastic morphological right ventricle, and normally related great arteries.

Interrupted aortic arch: interrupted or atresic arch, leading to complete distal disruption or obstruction to flow.

Jatene procedure: this procedure is an arterial switch operation and is a definitive treatment for transposition of the great arteries. Both the aorta and pulmonary arteries are transected. The aorta is anastomosed to the residual proximal pulmonary artery, which becomes the neo-aorta. The distal pulmonary artery is anastomosed to the residual proximal aorta. Commonly a Lecompte manoeuvre is carried out during this step. Crucial to the success of the procedure is the successful transfer of the coronary origins from the native aorta to the neo-aorta.

Konno procedure: in order to relieve LVOT obstruction associated with aortic valve annulus hypoplasia, the aortic valve is excised and an incision in the ventricular septum is made and patched open. The creation of a widened LVOT allows a larger aortic valve to be used. This can be with either a mechanical (Konno-Rastan), homograft, or autograft (Ross-Konno) replacement.

Lecompte manoeuvre: the distal main pulmonary artery is brought anterior to the aorta so that the left and right PA bifurcation straddles the anterior ascending aorta.

MAPCAs: major aorto-pulmonary collateral arteries. These vessels are likely dilated bronchial arteries and provide a degree of pulmonary blood flow. They can provide a portion or all pulmonary blood flow depending on the degree of pulmonary arterial flow, or presence (or absence) of alternative conduits for pulmonary blood flow (e.g. PDA, BT shunt). They are prone to stenosis.

Mustard procedure: an atrial switch procedure for patients with transposition of the great vessels that creates an intra-atrial baffle made of native pericardium or synthetic material. This redirects pulmonary venous blood through the tricuspid valve into the right ventricle, and systemic venous blood through the mitral valve into the left ventricle. By surgically creating atrio-ventriclular discordance, physiologic (but not anatomical) correction is achieved.

Norwood procedure: first of a three stage palliative process for patients with univentricular hearts. It involves transection of the pulmonary artery, amalgamation of the proximal pulmonary artery with aorta, aortic arch augmentation, atrial septectomy, and provision of pulmonary blood flow either through a systemic-to-pulmonary artery shunt (BT shunt), or via an RV-PA conduit (Sano shunt/modification).

Patent ductus arteriosus: Persistence of a patent ductus arteriosus results in left-to-right shunt from aorta to pulmonary artery, and can lead to pulmonary overcirculation, pulmonary hypertension and heart failure.

Potts shunt: fenestration-type direct communication created between descending aorta and left pulmonary artery. Designed to provide some pulmonary blood flow through a systemic-to-pulmonary communication.

Rastelli procedure: in situations such as certain sub-types of double outlet right ventricle, LV outflow is accomplished by routing blood across a VSD patch, which serves as a baffle. An RV-PA conduit provides pulmonary blood flow.

Ross procedure: for some cases of aortic valve replacement, the patient's own pulmonary valve (pulmonary autograft) is transposed to the aortic position. A cadaveric or bioprosthetic pulmonary valve is then used to replace the patient's native pulmonary valve. The advantage of this procedure is the superior longevity of an autograft compared with currently available homografts, and is the only option that provides the possibility of growth, thereby appealing for use in children.

Sano shunt: an RV-PA conduit.

Senning procedure: a similar procedure to the Mustard procedure, although autologous tissue from the right atrial wall or inter-atrial septum is used rather than the pericardium or synthetic material used in the Mustard procedure.

Starnes procedure: as an alternative to biventricular repair of Ebstein's anomaly, the Starnes procedure involves patch closure of the TV, reduction atrioplasty and/or RV plication, formation of an unrestrictive ASD, and creation of pulmonary blood flow through a mBT shunt, thereby creating single ventricle physiology.

Taussig-Bing anomaly: a heart with a double outlet right ventricle with a

subpulmonary VSD. Left ventricular oxygenated blood is preferentially streamed into the pulmonary artery, and therefore behaves physiologically as a heart with transposition of the great arteries.

Transposition of the great arteries: in *d*-transposition, there is ventricular-arterial discordance, whereby the aorta arises from the right ventricle and the pulmonary artery arises from the left ventricle. Treatment historically involved either a Mustard or Senning procedure. Current definitive treatment is a Jatene procedure (arterial switch). In the rarer *l*-transposition (synonymous with 'congenitally-corrected transposition'), there is both atrio-ventricular and ventricular-arterial discordance. The right atrium drains blood through a mitral valve into a right-sided morphological left ventricle, which ejects into the pulmonary artery. The left atrium drains blood through a tricuspid valve into a left-sided morphological right ventricle, which ejects into the aorta. Treatment may include a double switch, involving both a Senning and a Jatene procedure, to allow the morphological left ventricle to become the systemic pump.

Truncus Arteriosus: a defect in which the pulmonary artery and aorta exit the heart as a single trunk. There is a VSD, which the trunk overrides.

Ventricular septal defect: a defect in the ventricular septum. When large and unrestricted, this commonly leads to significant left-to-right shunting and pulmonary overcirculation. A number of types exist depending on position within the septum and relation to intracardiac structures, including inlet, outlet, perimembranous, muscular, and apical.

Waterston shunt: fenestration-type direct communication created between ascending aorta and right pulmonary artery. Designed to provide some pulmonary blood flow through a systemic-to-pulmonary communication.

Congenital references:

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Everett A, Lim D. Illustrated field guide to congenital heart disease and repair. 3rd edition. 2015. Scientific Software Solutions, Inc: USA.

Lake C, Booker P. Pediatric cardiac anesthesia. 4th edition. 2004 Lippincott Williams and Wilkins: London.

Ch. 6 – Drug information

General references:

Tomlin M, et al. A guide to parenteral drugs used on adult intensive care. 2008. Southampton General Hospital.

Ashley C, Currie A. 2009. The renal drug handbook, 3rd ed. Radcliffe Publishing: Oxford.

Antimicrobials:

Caspofungin:

Wt <80kg: 70mg od day 1, then 50mg od thereafter

Wt>80kg 70mg od

Moderate hepatic insufficiency: 70mg day 1, then 35mg od

Renal impairment/CVVH:

-GFR <10: Dose as in normal renal function.

- CVVHDF: Not dialysed. Dose as in norm. renal function

Cefotaxime:

1-2g BD or TDS

Meningitis: 2g 4hourly

Renal impairment/CVVH:
-GFR <10-20: Dose as in normal renal function
-GFR <10: 1g every 8-12 hours
- CVVHDF: Dialysed. 2G every 12 hours

Ceftazidime:

1-2g TDS

Renal impairment/CVVH:
-GFR 31-50 :1-2g every 12 hours
-GFR 16-30: 1-2g every 24 hours
-GFR 6-15: 500mg-1g every 24 hours
-GFR<5: 500-1g every 48 hours
- CVVHDF: Dialysed. 2g every 12 hours

Cefuroxime:

1.5gram TDS

Renal impairment/CVVH:
-GFR 10-20: 750mg-1.5g every 8-12 hours
-GFR <10: 750-1.5g every 12-25 hours
- CVVHDF: Dialysed. Dose as in GFR=10-20

Chloramphenicol:

(IV) 12.5mg/kg QDS (max 1gram QDS)

Renal impairment/CVVH:
-GFR <10: Dose as in normal renal function
- CVVHDF: Not dialysed. Dose as in norm function

Ciprofloxacin:

IV: 200-400mg BD

oral: 250-750mg BD

Renal impairment/CVVH:
-GFR 10-20: 50-100% normal dose

-GFR <10: 50% normal dose (100% dose for short periods under exceptional circumstances)

- CVVHDF: Dialysed. Oral 500-750mg every 12 hours. IV: 200-400mg every 12 hours.

Clarithromycin:

IV/oral 250-500mg BD

Renal impairment/CVVH - Use with caution:

-GFR 10-30 Oral/IV: 250-500mg every 12 hours.

-GFR <10: Oral/IV: 250-500mg every 12 hours.

- CVVHDF: Unknown dialysability. Dose as in GFR=10-30

Co-amoxiclav:

IV: 1200mg TDS

PO: 375-625mg TDS

Renal impairment/CVVH:

-GFR 10-30: IV: 1200mg every 12 hours

-GFR <10: IV: 1200mg stat followed by 600mg every 8 hours or 1200mg every 12 hours.

- CVVHDF: Dialysed. Dose as in GFR=10-30

Co-trimoxazole (Septrin):

IV/Oral: 120mg/kg/day in 2-4 divided doses

Renal impairment/CVVH:
-See Renal Drug Handbook

Daptomycin:

Renal impairment/CVVH:
-GFR 30-50: Dose as in normal function
-GFR <30: 4mg/kg every 48 hours
- CVVHDF: Slightly dialysed. 4-6mg/kg every 48 hours.

Erythromycin: (Prokinetic use)

IV/Oral: 500mg bd

Renal impairment/CVVH:
-GFR <10: 50-75% normal dose. Max 2gram daily
- CVVHDF: Unknown dialysability. Dose as in normal renal function.

Flucloxacillin:

IV/Oral: 250mg-1000mg QDS

Up to 8gram/day may be used in severe infections such as endocarditis

Renal impairment/CVVH:
-GFR <10: Dose as in normal function up to 4g max daily.

- CVVHDF: Not dialysed. Dose as in normal renal function.

Fluconazole:

Invasive candida: 400mg IV stat, then 200-400mg IV/oral od (caution in hepatic and renal failure and interacts with warfarin, phenytoin, ciclosposin and theophylline)

Renal impairment/CVVH:
-GFR <10: 50% normal dose.
- CVVHDF: Dialysed. 400-800mg every 24 hours

Gentamicin: See UHS micro guide

Meropenem:

Renal impairment/CVVH:

-GFR 20-50: 500mg – 2g every 12 hours

-GFR 10-20: 500mg -1g every 12 hours or 500mg every 8 hours

-GFR <10: 500mg – 1g every 24 hours

-CVVHDF: 1g every 12 hours

Metronidazole:

IV 500mg every 8 hours

Renal impairment/CVVH:

-GFR <10: Dose as in normal renal function

- CVVHDF: Unknown dialysability. Dose as in normal renal function.

Rifampicin:

600-1200mg daily in 2-4 divided doses

Renal impairment/CVVH:

-GFR <10: 50-100% of normal dose

- CVVHDF: Unknown dialysability. Dose as in normal renal function.

Tazocin (Piperacillin/Tazobactam)

4.5g every 8 hours

Renal impairment/CVVH:

-GFR 10-20: 4.5g every 8-12 hours

GFR <10: 4.5g every 12 hours

- CVVHDF: Dialysed. 4.5g every 8 hours

Teicoplanin:

400mg 12 hourly for 3 doses (loading), then 400mg daily.

Renal impairment/CVVH:

-GFR 10-20: Give normal loading dose, then 200-400mg every 24-48 hours

-GFR <10: Give normal loading dose, then 200-400mg every 48-72 hours

- CVVHDF: Unknown dialysability. Dose as in GFR 10-20

Vancomycin infusion:

1g loading over 2hours (consider 500mg if <40kg)

Then for infusion: make up 500mg in 100mL 0.9% NaCl.

Creatinine < 120 = Start at 13mL/hr

Creatinine > 120 or CVVH = Start at 8mL/hr

Do level daily at 6am (unless started within 6 hours)

If level <15mg/L	Increase dose/rate by next level up in table
If level 15-25mg/L	No change
If level >25mg/L	Decrease dose/rate by next level down in table
If level >30mg/L	Stop infusion for 6h and d/w consultant or pharmacist.

Daily Dose	3500 mg	3000 mg	2500 mg	2000 mg	1500 mg	1000 mg	500 mg	250 mg
Equivalent rate (5mg/ml)	29 ml/h	25 ml/h	21 ml/h	17 ml/h	13 ml/h	8 ml/h	4 ml/h	2 ml/h

Sedatives and anxiolytics:

Chlorpromazine:

25mg IM max TDS (Caution in Parkinson's, epilepsy, Myasthenia gravis)

Clonidine: see below

Dexmedetomidine: see below

Haloperidol:

1.25-5mg (contraindicated in parkinson's disease. Caution in liver disease and renal failure, epilepsy, and phaeochromocytoma)

Lorazepam

IV 1mg

Olanzapine:

IV/IM 2.5 -5mg PRN (unlicensed)

Procyclidine:

2.5mg – 5mg

Quetiapine:

po 12.5mg PRN

Clonidine

Introduction:

- Potent central Alpha2 agonist with weak alpha 1 activity, leading to sedation, analgesia, bradycardia and hypotension

- Increases TSH and GH, but decreases ADH and insulin secretion

Indication:

- Agitation/ - Hypertension

Dose Range:

- 300-900mcg/24 hrs

- Max 1200mcg/24 hrs

- PO 50-200 mcg TDS (max 300mcg at time)

Presentation:

- Compatible with 0.9% NaCl and 5% dextrose

- Make up 450mcg in 50mls

- Run at 0-6ml/h

Notes:

Side effects include, hypotension, bradycardia, depression, drowsiness with dry mouth and constipation.

Can cause rebound hypertension, tachycardia and restlessness or withdrawal. Therefore titrate dose down over a few days

Dexmedetomidine:

(ref: Guy's and Thomas' NHSFT)

Introduction:

- a2 agonist similar to clonidine

- Not for deep sedation

Indication:

- Failed trial clonidine (BP drop, HR)

- Difficult airway/ extubation

- High risk delirium (PRODEX/ MIDEX studies)

- NIV (lack resp depression)

Dose Range:

- 0.4-1.4mcg/kg/hr

- Start 0.8mcg/kg/hr majority

- 30-60 mins between dose changes of 0.1mcg/kg/hr

- Reduce by 0.1mcg/kg/hr increments -> 0.4mcg/kg/hr then stop

Presentation:

- 100mcg/mL (10mL) -> prepare to 20mcg/mL concentration in 50mL syringe with saline 0.9%

Shivering associated with hypothermia:

Skin counter-warming

Paracetamol

Pethidine 25mg IV

Magnesium

Chlorpromazine 25mg IM

Opiates incl. Meperidine 50-100mg IM/IV or fentanyl infusion

propofol infusion

Clonidine or Dexmedetomidine infusion

Neuromuscular blocking agents (last resort)

Acid/base special situations

Acetazolamide

Introduction:

- Carbonic anhydrase inhibitor. Reduces hydrogen ion excretion, raising urinary pH and acidifying plasma pH

Indication: Rhabdomyolysis

Stimulates respiration by acidifying plasma pH

Treatment of metabolic alkalosis

Dose Range:

- IV slowly 500mg BD for 3-5/7

Notes:

Causes flushing, headaches, thirst and acid/base/electrolyte imbalance, paraesthesia, ataxia, and hyperventilation.

Contraindicated/caution metabolic acidosis, tachypnoea, sulphonamide hypersensitivity, liver cirrhosis (increases risk of encephalopathy)

Cardiovascular drugs:

Adrenaline:

Introduction:

- Alpha, $Beta_{1+2}$ agonist. Increases cardiac output, peripheral vascular resistance, coronary blood flow, and heart rate.

- Increases myocardial O_2 consumption, platelet adhesiveness and blood coagulation, blood glucose, and is a metabolic and mild respiratory stimulant.

Indication:

- To increase inotropy and SVR

Dose Range:

- 0.01 mcg/kg/min – 1.0 mcg/kg/min

Presentation:

- Note two concentrations available:

1mg in 1ml ampule (1:1000)

AND

1mg in 10ml ampule or minijet (1:10,000)

- Add 1mg to a total of 50mls 5% glucose. Also compatible with dex/saline and 0.9% saline.

- Run at 0-20ml/h. Concentration can be double (2mg/50ml) or quadrupled (4mg in 50mls) as required.

Notes:

- GICU uses a stronger concentration (10mg in 100ml, equivalent to quintuple strength CICU strength).
- Incompatible with Sodium Bicarbonate

Renal impairment/CVVH:

-GFR <10 Dose as in normal renal function

- CVVHDF: Not dialysed. Dose as in normal renal function

Amiodarone:

Introduction:

- Class III anti-dysrhythmic, also with class I activity

- Slows AV nodal conduction. Also decreases SVR and increases coronary blood flow

Indication:

- Tachydysrhythmias, including supra- and ventricular tachycardias, atrial flutter and atrial fibrillation, and those associated with WPW syndrome

Dose Range:

- Loading dose: IV 5mg/kg (usually 300mg) over 1 hour, followed by 900mg over 23 hours

- Maintenance: IV 300-600mg/day (in a reducing dose), and consider switching to oral/ng formulation when appropriate

Presentation/compatibility:

- 150mg or 400mg vial/ ONLY COMPATIBLE with 5% DEXTROSE

- IV Loading dose: make up 5,g/kg (300mg) in 100-250ml 5% dextrose (Consider 100ml diluent for CVC administration,

whereas use250ml diluent for peripheral administration via large bore cannula), then make up 900mg in 500mls 5% dextrose

Notes:

Use a dedicated line, should be given centrally.

Peripheral use – use a large-bore cannula, and avoid longterm admin peripherally. Risks of hypotension and bradycardia, photosensitivity, GI upset, and longterm, corneal micro deposits, hypothyroidism, pneumonitis or lung fibrosis, and cirrhosis

Renal impairment/CVVH:

-GFR <10 Dose as in normal renal function

CVVHDF: Not dialysed. Dose as in normal renal function

Aprotinin:

Dose Range:

- Test Dose 10,000 units (1 mL)

- Load Dose 2 million units (x 4 syringes)

- Pump dose 2 million units

- Infusion ½ million units / hr (50mL/hr)

- TOT Dose = 7 million units (max 14 amps)

Atenolol

Introduction:

- Cardio-specific beta-blocker (Beta 1)

- Causes reduction in inotropy, leading to a fall in O2 consumption

Antihypertensive and antidysrhythmic properties

Indication:

- Angina, hypertension, tachydysrhythmias in acute phase of MI and prevention of re-infarction

Dose Range:

- IV Bolus: 1-2.5mg (max rate 1mg/min), repeated at 5min intervals to a max 10mg total

IV infusion: 150mcg/kg over 20mins, 12hourly

Beware IV/PO doses vary by a factor of 10.

Notes:

Side effects include bronchospasm, bradycardia, heart failure deterioration, postural hypotension.

Contra-indications:

Second or Third degree heart block or sick sinus syndrome

Uncontrolled heart failure/ Cardiogenic shock

Caution in COPD/Asthma

Reduce dose in renal failure

Renal impairment/CVVH:

-GFR <10: Dose as in normal renal function

- CVVHDF: Dialysed. Dose as in normal renal function

Atropine:

Introduction:

- Anticholinergic/antimuscarinic

-Blocks vagal activity leading to a relative tachycardia

Indication:

- Counter bradycardia

Dose Range:

- IV/IM 600mcg

Presentation:

- 600mcg vial

- 1mg minijets available

Notes:

Painful on IM injection

Causes dry mouth, and reduced salivary, bronchial secretions, and sweating

Calcium Gluconate:

Introduction:

- Essential for intracellular muscle and nerve function, including cardiomyocyte contraction

- Coagulation factor IV – Essential co-component of Clotting cascade

Indication:

- Hypo-calcaemia. Aim ionised Ca2+ (on blood gas) >1.15

- To increase heart contractility and vascular smooth muscle tone

- As a cardiac myocyte membrane stabiliser in hyperkalaemia

Dose Range:

- Slow IV bolus 10-20mls (at max rate of 2mls of 10% (0.44mmol) per min)

Presentation:

- 10ml ampule of 10% Calcium gluconate, containing 2.2mmol in 10mls

- Compatible with 0.9% Saline and 5% dextrose solutions

Notes:

Can cause:

nausea/vomiting/flushing/

vasomotor collapse/hypotension/ tachycardias

Caution in patients with hyperphosphataemia

Renal impairment/CVVH:

-GFR <10: Dose as in normal renal function. Titrate to response

- CVVHDF: Dialysed. Dose as in normal renal function

Digoxin:

Introduction:

- An antidysrhythmic drug that slows AV nodal conduction, thereby slowing ventricular response to AF. A positive inotrope. Also depresses SA node discharge

Indication:

- Atrial fibrillation or atrial flutter/ Chronic CCF/ Prevention of supraventricular dysrhythmias following thoracotomy

Dose Range:

- Loading dose: 500-1000mcg in 24h

- Maintenance dose: 62.5-250mcg od according to levels

IV/PO switch: Note 100mcg IV = 125mcg oral

Presentation:

- Compatible with 0.9% NaCl and 5% dextrose. Dilute in 50-100ml diluent (Max conc. 50 mcg/ml)

Notes:

SE include vasoconstriction, hypertension and decreased coronary blood flow with rapid injection, Anorexia, N&V, diarrhoea, headache, drowsiness, Dysrhythmias, 2^{o} and 3^{o} AV

block, Ectopics, atrial or ventricular dysrhythmias indicate overdose, Ventricular bi- or tri-geminy. Conatraindicated in 2º or 3º AV block

Monitoring:

Check level 6h post dose. - Aim 0.9-2.6 micromol/litre

Monitor Potassium: Hypokalaemia sensitises the myocardium to digoxin. Therefore Aim k>4

Renal impairment/CVVH:

-GFR 20-50: 125-250mcg/day. 10-20: 125-250mcg/day and monitor levels closely. <10: 62.5mcg daily or alternate days and monitor levels closely. Not dialysed. Dose as in GFR 10-20.

Dopamine:

Introduction:

- A noradrenaline and adrenaline precursor

- Has direct dopaminergic agonist effects, with additional beta-adrenergic and alpha adrenergic agonism with increasing concentration respectively.

Indication:

- To increase renal (and mesenteric) blood flow

- For inotropy in low cardiac output states

Dose Range:

1-3 mcg/kg/min: DA agonist increases renal blood flow

3-10 mcg/kg/min additional Beta agonism inotropic and chronotropy

>10mcg/kg/min additional alpha agonism increases SVR, PVR

Presentation:

- 200mg in 5ml vial

- Compatible with 0.9% sodium chloride and 5% dextrose

- Draw up 200mg in 50mls.

Rate 1-10ml/h

Notes:

- Risk of arrhythmias at higher doses

- Alpha mediated vasoconstriction outweighs dopaminergic renal vasodilation at high doses

Renal impairment/CVVH:

-GFR <10 Dose as in normal renal function.

- CVVHDF: Not dialysed. Dose as in normal renal function

Ephedrine:

Introduction:

- Positive inotrope

- Alpha agonist leading to vasoconstriction

Indication:

- Hypotension under anaesthesia

Dose Range:

- 3-6mg every 3-4mins. Max 30mg

Presentation:

- Compatible with 0.9% saline and 5% dextrose

Notes:

Side effects include headache, tremor, dysrhythmias, N&V

Esmolol:

Introduction:

- A relatively cardiospecific beta blocker with very short duration of action (Half-life 9 mins).

Indication:

- Short term treatment of supra-ventricular tachycardias

- Perioperative hypertension or tachycardia

Dose Range:

- Usually 50-200mcg/kg/min adequate

- A loading dose of 500mcg/kg/min for 1 min, followed by a maintenance dose of 50-200mcg/kg/min is reasonable for SVT or immediate control of perioperative tachycardia and hypertension

Presentation:

- 10ml vial containing 100mg (10mg/ml)

- Pre-made bags of 2500mg in 250mls (10mg/ml)

- Injection concentrate 250mg in 1ml – always dilute into 250mls 0.9% NaCl or 5% dextrose to make a concentration of 10mg/ml)

Notes:

- Can cause bradycardia, dizziness, heart failure, and venous irritation or thrombophlebitis. Therefore give centrally or via a large-bore cannula.

- Contraindicated in hypotension and bradycardia, 2º and 3º heart block, sick sinus syndrome.

- Caution in asthma and severe PVD.

- 80% Hepatically cleared. Therefore dose as normal in RF.

Renal impairment/CVVH:

-GFR <10 Dose as in normal renal function.

- CVVHDF: Unknown dialysability. Dose as in normal renal function

GTN:

Introduction:

- Vasodilation of arteries and veins

Indication:

- Hypertension

- Unstable angina

Dose Range:

- 10-100mcg/min

Presentation:

- Comes as 50mg in 50mls Neat

- Rate 1-10ml/h. Tachyphylaxis occurs in 8-24h

Notes:

Side effects include hypotension and possible reflex tachycardia, N&V and headaches.

Can cause ventilation/perfusion mismatch leading to increased right-to-left shunt and reduced oxygen saturations (due to uncoupling of hypoxic pulmonary vasoconstriction)

Contraindicated in severe haemorrhage, uncorrected hypovolaemia, severe hypotension

Renal impairment/CVVH:

-GFR <10 Dose as in normal renal function.

- CVVHDF: Not dialysed. Dose as in normal renal function

Isoprenaline:

Introduction:

- Beta 1 and Beta 2 agonist producing inotropy and chronotropy. The beta 2 activity also causes vasodilatation and bronchodilation.

Indication:

- Chronotropy for bradycardia refractory to atropine

- For the treatment of complete heart block

Dose Range (Bridge to pacing):

- 0.05-0.5mcg/kg/min

Presentation:

- 1mg in 10ml ampule or 2.25mg in 2ml ampule

- Compatible in 0.9% saline and 5% glucose

- Make up 4.5mg in 50mls.

- Run at 1-10ml/h

Notes:

- Can cause hypoxia and decreased renal blood flow, hyperglycaemia, palpitations, angina, dysrhythmias, hypotension.

EP experience:

200mcg (= 1 vial) make up to 50mL saline

Conc = 4mcg/mL

Run 50mL/hr ->100->150->300mL/hour according to electrophysiologist

Levosimendan:

Introduction:

- A cardiac muscle Calcium sensitizer.

- Works independently of cAMP and therefore should not interact with beta agonists or phospodiesterase inhibitors

Indication:

- Acute heart failure, usually when refractory to other agents

Dose Range:

- 0.1mcg/kg/min +/- loading dose 3 - 24mcg/kg over 10 mins (3 practical -> up to 6)

- Can go down to 0.05 or up to 0.2mcg/kg/min max

Presentation:

- 2.5mg/mL in 10mL vials

- Add x 1 vial to 250mL dextrose 5%

- Final conc = 50mcg/mL

Lidocaine infusion:

Introduction:

- Class I antidysrhythmic (Na+channel blocker)

Indication:

- Arrhythmia

Dose Range:

- Bolus/ loading dose 50-100mg IV
- 4mg/min for 30 mins (60ml/h)
- 2mg/min for 2 hrs (30mL/hr)
- 1mg/min for 24 hrs (15mL/hr)

- Max 200-300mg / hr

Presentation:

- 2000mg in 500mL glucose 5%

= 4mg/mL concentration

Notes:

- Contraindicated in Porphyria

Renal impairment/CVVH:

-GFR <10 Dose as in normal renal function.

- CVVHDF: Not dialysed. Dose as in normal renal function

Methylene Blue:

Introduction:

- Methylene Blue can increase SVR by inhibiting the activation of soluble guanylate cyclase and thereby blocking the synthesis of the potent vasodilator, nitric oxide.

Indication:

- Can be used to increase SVR that is refractory to noradrenaline and other vasopressors.

Dose Range:

- 1-2mg/kg bolus with 1-2mg/kg/hr infusion

- Smaller amounts may have dramatic clinical effect

Presentation:

- Available as 1% w/v solution (10mg/ml).

- Dilute into a suitable volume of 0.9% saline or 4% glucose 0.18% saline.

Notes:

- Contraindicated in glucose-6-phosphate dehydrogenase deficiency.

- Caution in severe renal failure due to accumulation

- Do not mix with other drugs

- Will cause discolouration of skin and urine.

- Can cause haemolytic anaemia, and methaemoglobinaemia after prolonged/high dose use, reduction in platelet count, and tissue damage if extravasation occurs.

Milrinone:

Introduction:

- A phosphodiesterase III isoenzyme inhibitor of cardiac and vascular muscle

- Produces positive inotropy and vasodilatation - Also causes lusitropy and dromotropy with little or no increase in chronotropy.

Indication:

- Low cardiac output, particularly in the setting of increased LVEDP, pulmonary hypertension or RV failure

- As an adjunct to beta agonists

Dose Range:

- 0.375-0.75mcg/kg/min

Presentation:

- Available as 10mg in 10mls.
- Compatible with 0.9% saline and 5% glucose
- Draw up 10mg of drug into 50mls diluent.
- Rate 5-10ml/h

Notes:

- Renally cleared. Therefore reduce dose in renal failure.
- 4h half life

Noradrenaline:

Introduction:

- Beta1 and alpha agonist. Causes increased SVR whilst also maintaining cardiac output.

Indication:

- Refractory hypertension secondary to vasoplegia

- Modulation of vasodilating drugs

Dose Range:

- 0.01-0.5mcg/kg/min

Presentation:

- Usual dilution is 4mg in 50mls or 8mg in 100mls.

- Compatible with 0.9% NaCl and 5% glucose.

- Run at 0-10ml/h.

- Concentrations may be doubled or quadrupled

Notes:

-Can cause peripheral ischaemia, reduced renal -blood flow at high doses, and hyperglycaemia

Phentolamine:

Introduction:

- Alpha antagonist, leading to a decrease in SVR

Indication:

- Acute hypertension

Dose Range:

- IV Bolus: 2-5mg, repeated as required

Notes:

- Can cause reflex tachycardia and dysrhythmias, diarrhoea, nausea and vomiting, increases gastric acid secretion.

- Contraindicated in myocardial infarction and hypotension.

Phenylephrine:

Introduction:

- Alpha agonist, leading to a rise in SVR.

Indication:

- Hypotension secondary to vasoplegia

Dose Range:

- IV bolus: 100mcg repeated as required

- IV infusion: 30-180mcg/min titrated according to response

Presentation:

- 1mg in 10mls (100mcg/ml)

- Beware 10mg in 1ml (strong phenylephrine) available. Requires dilution.

Common dilutions:

- 10mg in 100ml 0.9% NaCl bag (100mcg/ml)

- 10mg diluted to 10mls 0.9% Nacl (1mg/ml) for use only in CPB circuit by perfusionist

Notes:

- Causes reflex bradycardia, hypertension, dysrhythmias, nausea and vomiting, sweating, increased salivation, urinary retention.

- Contraindicated in hypertensive states. Caution with hyperthyroidism.

Sodium Nitroprusside (SNP):

Introduction:

- Potent arterial and venous vasodilator, reducing SVR.

- Causes cerebral vasodilation

Indication:

- Severe hypertension

- Acute heart failure

Dose Range:

- Hypertension: 0.5-8 mcg/kg/min

Presentation:

- Make up 50mg in 50mls

- Compatible with 0.9% NaCl and 5% glucose

-Run at 2-20ml/h

Notes:

Can causes cyanide toxicity, tachycardia, dysrhythmias and metabolic acidosis.

Antidote for cyanide toxicity is sodium thiosulphate (on CTITU, ED, and pharmacy)

Vasopressin:

Introduction:

- Act on V1a receptors on smooth muscle to produce vasoconstriction.

Indication:

- Refractory hypotension secondary to low SVR

Dose Range:

- Compatible with 5% dextrose.

-DO NOT MIX with other inotropes

-Make up 40 units in 40mls.

- Run at 2-3units/h

Notes:

Causes pulmonary vasodilation, increased cortisol, diuresis at low doses, platelet aggregation at high doses.

Ch. 7 – Notes