1 Resus

AIRWAY

Causes of Upper Airway Obstruction

- Imm: **Anaphylaxis**, Angio-oedema
- Anatomical: Tracheomalacia, subglottic stenosis
- CNS: **HI, CVA, ICH,** Drugs, Metabolic
- Neoplasia: Larynx, trachea, thyroid
- Trauma: Blunt/pen, bleeding, inhalational
- Infectious: Tonsillitis, quinsy, epiglottitis, deep tissue
- FB

Predictors of difficulty

Difficult BMV

MOANS

- **M**ask Seal
- **O**bstruction/Obesity
- **A**ge > 55
- **N**o teeth
- **S**tiffness of Cx eg asthma, COPD

Difficult LMA

RODS

- **R**estricted mouth opening
- **O**besity/Obstruction
- **D**istorted anatomy
- **S**tiffness of Cx

Difficult Intubation

LEMON-TE

- **L**ook (small jaw, big tongue)
- **E**valuate 3-3-2
- **M**allampati
- **O**besity/Obstruction
- **N**eck mobility
- **T**MJ dysfcn, tumour, trauma
- **E**xperience (known)

Pregnancy or Obese

- Oedema
- ↓ Neck ROM
- ↑ Aspiration
- ↑ Cx size (Δ handle)

3-3-2 = 3cm mouth opening, 3cm Thyromental, 2cm thyrohyoid

Difficult Surgical Airway

SMART

- **S**urgery prior
- **M**ass eg abscess
- **A**ccess/anatomy
- **R**adiation
- **T**umour/trauma

Intubation

Indications

- **Anticipated clinical course**
- **Failure to oxygenate/ventilate/protect the airway**

Examination Findings for Intubation

- Absent gag
- Overt bleeding (from anywhere, UGI, local, neck)
- Facial burns
- Neck swelling/SC emphysema
- ***Stridor, FB, abnormal voice, drooling***

Contraindications

- High risk of aspiration
- Difficult airway: known/suspected
- Inability to perform surgical airway
- Upper airway obstruction: FB, cancer etc, transection
- Haemodynamically unstable

Complications

- Procedure: Failed, surgical, trauma, PTx, ↓O_2
- Induction: ↓HR/BP, ↑ICP, Awareness
- Aspiration

Hypotension

- A: anaphylaxis
- B: tPXT, hyperinflation
- C: AMI
- D: induction agents

***Hypoxia** (DOPESM)*

- **D**islodged ETT, RMB
- **O**bstruction
- **E**quipment failure: vent, ICC
- **P**Tx, Pulm **C**ontusions
- **S**tacking, **S**pasm (broncho)
- **M**ucous plugging

Equipment

Laryngoscope

- Handles: short, penlight, normal
- Blades: *curved:* Macintosh, Kessel, McCoy (adjustable tip)
  straight: Magill, Miller & Wisconsin
- ***Size: 4 = Avg***
- Paed:

age	< 1	1	2	10
size	0	1	2	3

*NB use straight blades in kids since epiglottis is floppier – be careful because epiglottis is innervated by vagus nerve (not IX) = **bradycardia***

Endotracheal Tube

		ETT ID Sz	ETT Length
NB	Preterm	2.5	Weight (kg) + 6cm
NB	Term 2-3kg	3	
NB	**Term > 3kg**	**3.5**	
Infant	≤ 6months	3.5-4	
Infant	6-12 months	4	
Kid	**> 1year**	**age/4+4**	**age/2+12**
Adult	Female	7.5	3x ETT sx (~22cm)
Adult	Male	8.5	

NB Newborn

Confirmation

- Direct visualisation
- Misting of tube
- Auscultation
- Ultrasound
- Chest rise & fall
- $ETCO_2$
- Cxr

Post Intubation Care

- ***Analgesia, Sedation, Relaxant***
  - ***Morph/Midaz*** 50mg in 50ml @ 5-20 ml/hr
  - ***Propofol*** 4-12 mg/kg/hr (30-100 ml/hr)
- Procedures: IDC, IAL, NGT
- Ix: Cxr
- 1ry pt care: pressure areas, eyes
- 2ry pt care: 2° brain injury

Drugs

*Goal is for **ideal intubation conditions** ie stable haemodynamics and optimal airway – lack of awareness and amnesia is also nice if you can…*

Muscle Relaxants

Succinylcholine	1-2	mg/kg
Rocuronium	1.2	mg/kg **IBW**

Need to ↑ dose of roc for chronic anticonvulsants

Induction Agents

Ketamine	1-2	mg/kg **IBW**
Fent, Midaz	1, 0.15	µg, mg/kg
Fent, Propofol	1, 1.5	µg, mg/kg
Thiopentone	1-5	mg/kg

Special Scenarios

- **HI** use ***Fentynl*** 2-3µg/kg ± ***Lignocaine*** 1.5 mg/kg
- **Shock use more relaxant/less induction**
  - ***Ketamine*** 0.5 mg/kg
  - ***Fent*** 0.5 µg/kg
  - ***Sux*** 4 mg/kg
  - ***Roc*** 1.6 mg/kg

Peri-intubation

Atropine	20	µg/kg (0.6mg aliquots)
Sugammadex	16	mg/kg (for ***roc*** 1.6mg/kg)
Propofol	4-12	mg/kg/hr (30-100 ml/hr)
Morph/Midaz	0.05-0.2	mg/kg/hr
Rocuronium	50	mg
Noradrenaline	5-20	ml/hr (6mg/100ml)
Adrenaline	10-50	mcg
Metaraminol	0.5-1.0	mg

Special Airways

1. Obese

Buy time – DSI/NIV, optimise physiology
Indications – can it be done in OT or not at all
Get help – anaesthetics, ENT
Ramp – tragus to sternal notch
Apnoeic Oxygenation: ***NP 15L/min***
Minimal drugs – use IBW ie ***Ketamine/Rocuronium***
Pre-oxygenate – BVM & ***PEEP valve, NIV***
Paralysis
Plan for failure – difficult trolley, double setup
Post intubation care

2. Pregnant

- Similar concept to Obese
- ***Smaller ETT***
- ***Wedge*** under R hip
- Laryngoscope: short handle, kessel blade

3. Sepsis/Shock

- Optimise physiology eg fluid, ***noradrenaline***
- Drugs: **↓ Induction dose + ↑ Relaxant dose**
  - ***Ketamine*** 0.5 mg/kg
  - ***Rocuronium*** 1.6 mg/kg
- ***Maintain resp compensation*** if present (ie RR)

4. Trauma & Head Injury

- Minimise BP by ↑ Induction dose
  - ***Lignocaine*** 1.5mg/kg (no evidence)
  - ***Fentanyl*** 2-3 µg/kg (typically 200 µg)
  - ***Rocuronium*** 1.2mg/kg (usual dose)
- In-line stabilisation = difficult airway → anticipate

5. Asthma

- Hypotension likely – ***fluid bolus prior***
- DSI/NIV/BVM+PEEP if able
- Drugs: ***Ketamine*** (β-agonist) & ***Rocuronium***
- Use ***larger ETT*** to ↓ stacking
- Vent Settings – see *vent strategies*

6. Paediatrics

- Straight blade
- Drugs: 1. ***Rocuronium*** + ***Thiopentone*** or
  2. ***Rocuronium*** + ***Fentynl*** + ***Midazolam***
- ETT size = age/4+4, depth = age/2+12
- ***ETT Uncuffed better***

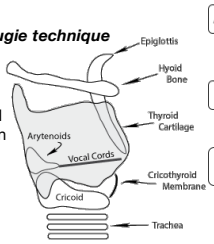
CICO

Alternative

- SGA
- Fibre optic
- ESA
- Retrograde intubation
- Blind intubation

Surgical Airway: Scalpel-knife-bougie technique

- Stabilise thyroid cartilage
- Palpate CTM
- 4cm ***vertical*** incision over CTM
- Wide horizontal incision INTO CTM
- Dilate with finger & confirm location
- Bougie & ***Sz 6 ETT***
- Connect & Confirm



Paed ESA

- ***14G needle*** into CTM

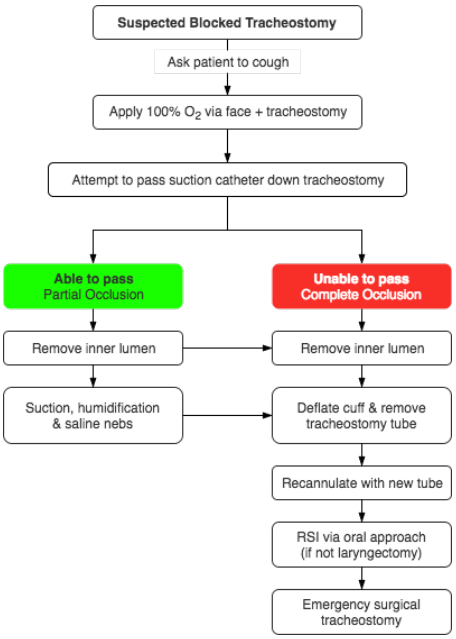
High Flow Jet Ventilation (HFJV)

- 1-3 ml/kg
- 50mmHg (adults)
- Passive expiration important
- I:E 1:5 RR 12

Transected Airway

- Above or Below cricoid cartilage?
  - Above = unlikely to recoil into chest
  - ***Below*** = anticipate recoil
- **DO NOT BMV, PPV, Intubate!** Unless necessary
- CICO = ***tracheostomy*** not cricothyroidotomy
- Sternotomy may be required

Blocked Tracheostomy Tube



Extubation

Suitability

ABCDEFGH

Airway grade 1 (maybe 2)
Breathing on FiO_2 < 40%, minimal PEEP
Circulation normal/unsupported or 'stable'
Disability: obeys, no weakness, TV > 1L
Electrolytes & pH normal
Fluids: neutral balance
GIT: no abdo distention, feeds absorbing
Hb normal

Other Factors

STORE

- Staff: skill, additional available if required
- Time of day
- Other planned procedures for pt
- Equipment eg NIV availability
- Resource allocation eg busy department

Complications

- A: asp, cough, sore, post ex stridor, re-intubation/CICO
- B: hypoxia, bronchospasm, resp failure (-ve p APO)
- C: hypotension

Airway Foreign Body

BREATHING

Ventilation Strategies

	Protective	*Restrictive*
When	Most situations	**Asthma, COPD**
Mode	SIMV	SIMV
TV	6 ml/kg IBW[1]	6 ml/kg IBW
RR	**16-18**[2]	**6-8**[4]
Pmax	< 40	< 45
Pplat	< 30	< 30
FiO2	88-95% Sats[3]	88-95% Sats
PEEP	To FiO_2[3]	**0**
I:E	**1 : 1.5 (default)**	**1 : >5**
Other	-	***AutoFlow: fast insp Sedate & paralyse***[5]

[1]*Titrate to Pplat < 30*
[2]*Titrate to pH,* ***match if septic or compensating!!!***
[3]*Titrate to PEEP eg 90% = 15, 40% = 5*
[4]*Permissive hypercapnia as long as pH >7.1*
[5]*Prevent asynchrony*

Other Strategies

- Head injury: Use less PEEP
- Metabolic acidosis: Lighten for vol breathes
- Hypertensive APO: PEEP = 10 & fast
- Cardiogenic shock: Use less PEEP (↑ preload)
- **Pregnancy:** **TV 8ml/kg, RR 18-20**

Non-Invasive Ventilation

BiPAP for high airway resistance, CPAP for all else

Indications: Adults

- T1 RF
  - APO
  - Post extubation stridor
  - Hypoxia eg CF, Pneumonia
- T2 RF
  - Hypercapnia: tiring COPD or Asthma etc
- Limitations of therapy

Indications: Kids

- Altered breathing ctrl *eg central hypoventilation syndrome*
- Neuromuscular weakness eg DMD, SMA
- Upper Spinal Cord injury (partial)
- Subacute upper airway obstruction
  eg tracheobronchomalacia, craniofacial abnormalities)
- Chronic Lung Disease
- Obstructive Sleep Apnoea

Contraindications

- Mask
  - Uncooperative, ***mask intolerance***, claustrophobia
  - ***ALOC***
  - Facial anomalies
- Airway
  - unable to protect airway eg hypersalivation, no gag
  - vomiting, haemoptysis
- Breathing: anticipated prolonged
- Circulation: ***unstable***
- Limitations of therapy

Complications

- Airway: Aspiration, aerophagia, ***delayed intubation***
- Breathing: Barotrauma eg ***PTx***
- Circulation: ↓ BP
- Disability: Intolerance, ↑ ICP
- ***Excess O_2 utilisation*** eg transport consideration

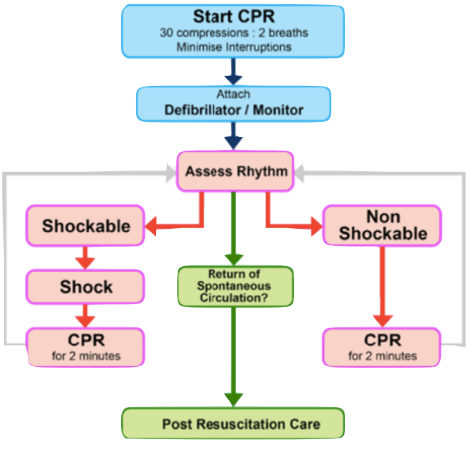
CARDIAC ARREST

Principles

- Chain of survival
- Minimise interruptions to compression
- Defib ASAP
- Aim for Normothermia & avoid too little/much O_2

Other Manoeuvres & Drugs

- ***Precordial thump*** if witnessed VT & no defib
- ***Stacked shock*** (x3) if witnessed + *can give < 30s*
- ***$NaHCO_3$*** 2mmol/kg if ***CPR > 15min***
- ***Wedge R hip if pregnant***
- ***CaCl & $NaHCO_3$*** if bizarre wide complex tachycardia



Confirmation of Shock Delivered

- Muscle response (pt jumping out of bed)
- ECG trace

Causes of undelivered shock

- Set to synchronised
- Flat battery
- Lead fracture
- Charge dumped
- Pad(s) not in contact with skin
  eg burns, sweat, hair

Post ROSC Management

- Seek & Treat ***cause*** eg PCI
- ↓ BP = ***Adrenaline*** 6mg in 100ml, 5-20ml/hr
- Recurrent VF/VT = ***Amiodarone*** 15mg/kg/day
- Sedation (***M&M*** 50mg/50ml 5-20ml/hr)

Post ROSC Targets

- Normothermia
- SpO_2 94-98%
- Normal pH, pCO_2, Glc

Special Arrest Situations

Anaphylaxis

- Use ACLS ***Adrenaline*** dosing ie IM/IO/IV ***1mg***
- Prolonged CPR
- Fluids ++

Asthma

- Disconnect, forced expiration
- Seek & treat ***tPTx***
- Prolonged CPR
- Fluids ++

PE

- Lysis: ***Alteplase*** 100mg total:
  < 60kg = 10mg bolus, ***1.5mg/kg*** over 2hrs
  > 60kg = 10mg bolus, 90mg over 2hrs
- ***Heparin*** infusion once done

Trauma

1 Stop ***catastrophic*** bleed	6 Plug ventricular lac
2 Open airway	7 Compress Aorta
3 Decompress chest	8 Twist Hilum
4 Open chest	9 MTP
5 Decompress pericardium	10 If crush think K

Pregnancy

- Wedge R hip to offload IVC
- Save the mother then the baby
- Give ***$MgSO_4$*** 6g IV just in case

Indications for peri-mortem LUCS/resus hysterectomy
- Maternal arrest +
- Uterus above umbilicus or known > 20/40
- ***< 15min or FHR still detectable***

Hypothermia

< 20C	Intermittent CPR (5m on 10m off)
< 28C	Intermittent CPR (5m on 5m off)
< 30C	No drugs, 3 shocks total max
30-35C	x2 interval for drugs, shocks as usual

Prolonged CPR

PHAATY

- PE following thrombolysis
- Hypothermia
- Anaphylaxis
- Asthma
- Toxicology/Toxinology
- Young

Stopping

- Injuries not compatible with life
- NFR order
- ***K > 12, pH < 6.5***
- No SOL T ≥ 32C or ***2hr CPR T < 15C***
- ***> 30min without ROSC*** (reset timer if ROSC)
- Premorbid states taken into consideration

During CPR
Airway adjuncts (LMA / ETT)
Oxygen
Waveform capnography
IV / IO access
Plan actions before interrupting compressions
(e.g. charge manual defibrillator)
Drugs
Shockable
* Adrenaline 1 mg after 2nd shock
(then every 2nd loop)
* Amiodarone 300mg after 3 shocks
Non Shockable
* Adrenaline 1 mg immediately
(then every 2nd loop)
Consider and Correct
Hypoxia
Hypovolaemia
Hyper / hypokalaemia / metabolic disorders
Hypothermia / hyperthermia
Tension pneumothorax
Tamponade
Toxins
Thrombosis (pulmonary / coronary)

Post Resuscitation Care
Re-evaluate ABCDE
12 lead ECG
Treat precipitating causes
Aim for: SpO2 94-98%, normocapnia and normoglycaemia
Targeted temperature management

SHOCK

Targets

Physiology

- ***MAP 65mmHg*** - CVP > 10 or Δ 7 - HR < 100
- SBP 90mmHg - CCR < 4

Perfusion

- UO > 0.5, 1, 2ml/kg (adults, kids, infants)
- Lactate < 2

Neurogenic Shock

Distributive shock with ↓ HR/BP, Priapism, Urinary retention, flaccid paralysis below level, resp compromise if above C4

- Fluids, ***Noradrenaline*** - Normothermia
- ***Atropine*** - Fix/stabilise cause

Cardiogenic Shock

- PCI, CTS
- STEMI Mx
  - ***Aspirin*** 300mg - O_2
  - ***Ticagrelor*** 180mg - ***Lipitor*** 40mg
  - ***Heparin*** 5000u IV
- ***Norad, adrenaline, dopamine***
- IABP, ECMO

Hypovolaemic Shock

Classification

Class IV	ALOC	> 40%	>2L
Class III	Low BP	30-40%	1.5-2.0L
Class II	Tachycardic	15-30%	0.75-1.5L
Class I	Normal signs	< 15%	< 0.75 L

Volume assessment

- USS (>50% IVC variability)
- Pulse pressure or stroke volume variation (only in vent pt)
- CVP Δ (not absolute reading)
- Passive leg raise (equivalent of 300ml bolus of blood)

Intraosseous

Contraindications

- Bone #
- Limb prox #
- Site of prev attempt
- Overlying infection
- Osteoporosis
- Osteogenesis Imperfecta

Complications

- Injury to staff
- Failure of device
- Fracture
- Fat embolism
- Growth plate arrest
- Osteomyelitis
- Extravasation → comp synd

Bloods on IO

- pH, CO_2
- Na, Crea, Glc
- Hb
- BC

Sites

- Proximal **Humerus** 2-3cm below tubercle
- Proximal **Tibia** 1-2cm below **medial** tuberosity
- Distal **Tibia** above **medial** malleolus
- Distal **Femur** above external condyle
- **Sternum** (specialised device)
- Other: ***iliac crest, clavicle, calcaneus***

Vasoactive Agents

Vasopressors

1. ***Noradrenaline***	100 mcg aliquots*	5-20ml/hr**
2. ***Metaraminol***	0.5 mg	5-10mg/hr
3. ***Dopamine***		1-5 mcg/kg/min

Inotropes

1. ***Adrenaline***	10mcg aliquots*	5-20ml/hr**
2. ***Isoprenaline***		5-10 mcg/min
3. ***Dobutamine***	*no peripheral effects*	1-40 mcg/kg/min

Other

1. ***Levosimendan*** 0-0.2 mcg/kg/min

**Use 1ml 1:10,000 + 9ml NS; 1ml = 10mcg*
***Use **6mg/100ml 5%D**; 0-20ml/hr = 0-20 mcg/min*

Endotracheal Agents

Dose is 2-3x IV, dilute in 10ml NS and syringe down ETT ie NOT neb etc

Adrenaline	3 mg	***Naloxone***	1.2mg
Atropine	1.8 mg	***Midazolam***	5mg
Lignocaine	3mg/kg	Ca Gluconate	2.5%

All others potentially pneumonitic

Mechanical Perfusion Adjuncts

Intra Arterial Ballon Pump (IABP)

- counter-pulsation device
- inflates during diastole (80% occlusion) → ↑coronary flow
- indications:
  - Cardiogenic shock: severe IHD, MR
  - Post MI
  - Post CABG
  - CM
  - Post myocardial contusion

ECMO

- indications: acute, severe, ***reversible*** resp or CV failure

VV
- most common
- vein → ECMO → vein near RA
- used in resp failure ie ***gas exchange only***

VA
- vein → ECMO → artery near aorta
- used in CVS failure (± resp) ie ***pump & gas exchange***

Ventricular Assist Device

- Bridge to therapy
- Not an acute option
- LV → Aorta
- Other ADs: RVAD (RV → PA), BiVAD (LVAD + RVAD)

HYPERTENSIVE CRISIS

- BP ≥ 140/90
- Hypertensive ***urgency*** = no end-organ damage
- Hypertensive ***emergency*** = end-organ damage

Causes

Potential hypertensive emergencies - **PACES*

- **P**regnancy: Pre/eclampsia*
- **A**ortic Dissection*
- **C**ardiac: AMI (early), APO*
- **E**ncephalopathy* (ALOC, HTN, retinopathy)
- **S**troke: ISchaemic/Haemorraghic*
- Renal stenosis, AKI
- Endocrine: thyrotoxicosis, Cushing's, Pheo
- Autonomic
- Pain
- Drug withdrawal
- Drugs: illicit, SSRIs, MOAIs

Paediatric Causes

- Dysplastic kidneys
- Reflux nephropathy
- GN
- Coarctation

Hypertensive Urgency

- Oral, correct within 24-48hrs
- ACE-I 1st line eg ***Ramipril***

Hypertensive Emergencies

See table for management

- IV, correct within 1-2hrs (BP 25%)

Cerebral Autoregulation

- Autoregulation via Δ cerebral vascular resistance
- CPP = MAP - ICP = 60-160 mmHg (doctrine of KM)
- Ideal CPP for TBI = 50-70 mmHg
- ICP > 20 mmHg in TBI

∴ CPP = MAP - ICP
MAP = CPP + ICP = 50-70 + 20 = **70-90 (aim 85)**

MONITORING

MAP = DBP + (SBP – DBP) ÷ 3
Shock Index = HR ÷ SBP

Min pressures for palpable pulse

- 80mmHg Radial, 70 Femoral, 60 Carotid

Min MAP for perfusion

- 50 = heart, 60 = kidneys

Capnography

Interpretation in Arrest

- ↓ = compression fatigue
- Abrupt ↑ = ROSC
- Prognosis: @30min ***> 20 = high chance ROSC***
  < 10 = low chance ROSC

Errors in Pulse Ox Measurement

- Non-arterial pulsation
- Anaemia or non-oxy Hb eg MetHb (sat 85% max)
- Read failure eg nail polish, pigmented skin
- Motion artefact
- External light or radio frequency

CARE OF DYING

- environment: single room, low traffic
- personnel: religious figure, social work
- drugs (all submit q2h)

glycopyrrolate	0.2-0.4 mg
haloperidol	0.5-1 mg
morphine	1-2mg
midazolam	2.5-5 mg

Hypertensive Emergency Management

Path	Target BP[1]	1st Line	Other Lines	Notes
Stroke (Isch)	< 220/110; 180/105[2]	***Esmolol*** **Bolus: 0.5 mg/kg Inf: 0.05-2.0 mg/min**	***GTN, Hydralazine***	Minimise extension
Stroke (Haem)	SBP>120, MAP ≥ 85		***SNP, Nifedipine[3]***	Minimise bleed
Encephalopathy	↓ 25%		***GTN, SNP, Metoprolol***	Tx underlying cause
Dissection	SBP 110		***GTN, SNP***	BP 2nd line (HR 1st)
Sympathomimetic	Normal	***GTN, SNP***	***Phentolamine***	
HOF/APO	SBP < 120	***GTN***	-	NIV, Frusemide, O_2
Pre-eclampsia	SBP 140-160	***$MgSO_4$ + Labetalol***	***Hydralazine, Nifedipine***	Deliver baby!

ICH Intracerebral Haemorrhage; HOF High Output Failure
Labetolol: 20mg q10min; ***Hydralazine*** 5mg q20min; ***GTN*** 50mg in 50ml, 3–20ml/hr; ***SNP*** 0.5–10 mcg/kg/min; ***Metoprolol*** 1mg aliquots; ***$MgSO_4$*** 6g then 2g/hr; ***Nifedipine*** 10mg q30min
[1] In addition to re-established organ perfusion
[2] 220 if treatment conservative, 180 if lysis
[3] Prevents vasospasm down the track

Phase		Physiology	Pathology
IAL Waveform			
1	Systolic Upstroke	Ventricular ejection	Less acute upstroke = AS
2	Peak Systolic Pressure	High pressure	High peak = poor arterial compliance
3	Systolic Decline	End LV contraction	Steep decline & Bisferiens pulse = LVOT obstruction or AR
4	Dicrotic Notch	AV closure	Delayed notch = ↓ SVR; Absent = AS, Deep = AR
5	Diastolic Run-off	Remainder LV contraction	-
6	End Diastolic Pressure	Lowest BP	-
IAL Measurements			
MAP = AUC			
Pulse Pressure = PSP - EDP			
CVP Waveform			
Waves	**A**	RA contraction	Wide = AR, Narrow = AS
	C	RV contraction (TV closed)	Absent = AF
	V	RA filling (TV closed)	-
Descents	**X**	↓ Contraction of RV, relaxation of RA	Large = TR
	Y	TV opening	Damp if ↓ RV filling eg PE, pHTN, Tamponade