

Temporary Pacing

Indications

- Provide AV synchrony e.g. complete heart block, nodal rhythms, junctional ectopic tachycardia (JET).
- Increase heart rate and optimise cardiac output e.g. sinus bradycardia, heart block.
- Allow overdrive pacing.

Types of temporary pacing

- Epicardial – post cardiac surgery. Wires inserted on epicardium at time of surgery – white wires atrial and blue wires ventricular. Paced via external pacing box. **Most frequent form of pacing on PICU.**
- Transcutaneous – via pads on defibrillator.
- Transvenous – via pacing wire inserted via large vein into right ventricle. Pacing wire attached to pacing box. Emergency pacing for life-threatening bradyarrhythmia's. Only paces ventricle.

Cardiac conditions with risk of arrhythmias

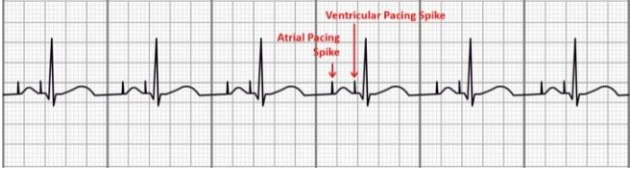
- Low risk surgery – PDA ligation, PA bands, coarctation repair, aortic arch repair, vascular ring, BT shunt
- High risk surgery:

Sinus bradycardia	ASD, Glenn/Fontan, Pulmonary hypertension
1 st degree heart block	ASD, Glenn/Fontan
2 nd degree heart block	ASD, VSD, AVSD
3 rd degree heart block	VSD, AVSD, Tetralogy of Fallot
SVT	Atrial surgery, Pulmonary vein surgery
JET	VSD, AVSD, Tetralogy of Fallot
Nodal/junctional rhythm	VSD, AVSD, Tetralogy of Fallot
VT	ALCAPA, Ventriculotomy

- Congenital complete heart block
- Right atrial isomerism – 2 sinoatrial nodes
- Left atrial isomerism – no sinoatrial node. Risk of complete heart block

Always ensure electrolytes optimised

International pacing nomenclature	<ul style="list-style-type: none"> • 1st letter = chamber paced • 2nd letter = chamber sensed • 3rd letter = response to sensing 					
Most common temporary pacing modes	<ul style="list-style-type: none"> • Selection of mode is based on reason for pacing (AAI used in preference to VVI if appropriate) • Aim to achieve cardiac synchrony with minimum cardiac stimulation 					
	Single chamber	Pacing mode	Chamber paced	Chamber sensed	Response to sensing	Uses
		VVI	Ventricle paced	Ventricle sensed	Ventricular activity inhibits pacemaker	<ul style="list-style-type: none"> • AV block and no AV synchrony • Severe bradycardia • Safest mode
		AAI	Atrium paced	Atrium sensed	Atrium inhibited	<ul style="list-style-type: none"> • Sinus bradycardia with intact AV node
	Dual chamber	DDD	Atria and ventricles paced	Both chambers sensed	Atrial activity triggers ventricular pacing (if no V event sensed) or inhibits ventricular pacing (if V event sensed)	<ul style="list-style-type: none"> • All types of heart block • JET • Overdrive pacing
		DVI	Atria and ventricles paced	Ventricle sensed	Ventricular activity inhibits atrial and ventricular pacing	<ul style="list-style-type: none"> • Sinus bradycardia or atrial arrest with atrial lead malfunction (oversensing)
		DDI	Atria and ventricles paced	Both chambers sensed	Atrial activity inhibits atrial pacing. Ventricular activity inhibits ventricular pacing.	<ul style="list-style-type: none"> • Sinus bradycardia with AV block and intermittent atrial tachyarrhythmias (avoids tracking fast atrial events)

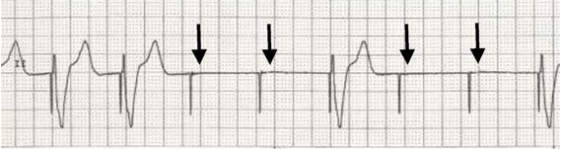

<p>Quick start initial settings</p>	<ul style="list-style-type: none"> • Press red button on pacing box – EMERGENCY PACING • Select DDD mode (used in emergency for ‘quick start’ pacing) • Increase rate to 100-160bpm depending on age of child or to rate required to optimise cardiac output • Sensitivity = level above which any sensed electrical activity is recognised by pacemaker as cardiac event: <ul style="list-style-type: none"> • Atrial sensitivity – 0.5 • Ventricular sensitivity – 2.0 • Stimulation (output) = energy required to stimulate chamber to contract: <ul style="list-style-type: none"> • Atrial stimulation – 5.0 (increase output/stimulation until pacing captured) • Ventricular stimulation – 5.0 (increase output/stimulation until pacing captured) • Increase output to achieve pacing • AV delay (represents PR interval of normal ECG) – 100ms infants, 120ms toddlers, 150ms older children. In DDD, gap between spikes is AV delay • Need to check ECG capture i.e. when there is sufficient energy/output to cause depolarisation and contraction. Presence of pacing spikes does not always mean capture and improved cardiac output • Assess pulse and patient and adjust output if required
<p>Pacing spikes</p>	<ul style="list-style-type: none"> • Appear before chamber being paced • If dual chamber pacing (DDD) will see both atrial spike and ventricular spike • Spikes on monitor does not always mean capture – check if atrial spike is followed by P wave and ventricular spike is followed by QRS complex 
<p>Checking threshold</p>	<p>Threshold = minimum amount of energy required to cause the chamber to contract:</p> <ul style="list-style-type: none"> • Check each shift especially if pacing dependent (rising thresholds indicate wires beginning to fail) • Turn output (V. STIM or A. STIM) down until no complexes on ECG following pacing spike. Output at which complexes change/disappear is threshold (e.g. if lose complex at 3.5, threshold will be 4.0 i.e. 0.5 above where pacemaker will generate complex). • After checking threshold, set output twice above this number (max 18.0v) • Even if fully reliant on pacing, threshold needs to be checked daily

Additional information on how to perform sensing and threshold testing:

<https://www.youtube.com/watch?v=u6wRASAFTRk>

<https://www.piernetwork.org/eppic.html> (PIER Network EPICC Video)

Troubleshooting (See additional 'Troubleshooting flow chart')

<p>Failure to capture</p>	<p>Visible pacing spikes seen on ECG but no electrical capture on ECG or cardiac contraction seen in arterial line or SpO₂ waveform:</p> <ul style="list-style-type: none"> • Commonest cause is due to mechanical problem e.g. wire dislodgement, wires not tightly connected to cable, output setting too low. Other causes include fibrosis at wire attachment site, MI, electrolyte imbalance, drugs (e.g. Flecainide, Beta-blockers, Lignocaine, Verapamil). • Dependent on mode being used, will see no P wave after atrial pacing spike and/or no QRS after ventricular pacing spike • Action: Increase output (Atrial stimulation or Ventricular Stimulation) until P wave/QRS complex seen after pacing spike) • If bipolar leads, try reversing position or try unipolar pacing. In bipolar leads, negative electrodes develop fibrosis first, so trial other electrode, plug into negative terminal and insert return electrode in subcutaneous tissue (create unipolar circuit) • If output too high, may pace diaphragm – need to reduce output 
<p>Failure to sense</p>	<p>Pacemaker does not sense heart's native beat and tries to pace/inhibit inappropriately:</p> <ul style="list-style-type: none"> • Will see random pacing spikes not related to P wave or QRS. Risk of R on T which can lead to VF • Usually due to incorrect sensitivity or damaged pacing wires • Action: Try pausing (heart may perform better when pacing stopped – can be sign of recovery). If this does not work see 'undersensing/oversensing' below 
<p>Undersensing</p>	<p>Pacemaker fails to detect spontaneous myocardial depolarisation resulting in asynchronous pacing:</p> <ul style="list-style-type: none"> • Atrial or ventricular pacing spikes appear regardless of P waves or QRS complex. Typically results in appearance of too many pacing spikes on ECG • Risk of R on T • Action: Decrease sensitivity number on dial i.e. pacemaker is more sensitive to heart's native beat
<p>Oversensing</p>	<p>Occurs when electrical signals inappropriately recognised as native cardiac output and pacing is inhibited:</p> <ul style="list-style-type: none"> • Produces inappropriate/excessive inhibition of pacing – confuses pacemaker into thinking there has been return to spontaneous atrial activity • Inappropriately large P or T waves, skeletal muscle activity or poor lead contact • Action: Increase sensitivity number on dial i.e. pacemaker is less sensitive to heart's native beat
<p>Causes of pacing failure</p>	<ul style="list-style-type: none"> • Battery failure • Wire dislodgement or can become fibrosed longer in situ • Insufficient output – will see pacing spike but not capturing output. Can be fatal. • Need to increase output up to maximum (20mA atrial and 25mA ventricular) • Prepare for transcutaneous pacing, CPR and chronotropic drugs
<p>Management of pacemaker failure</p>	<ul style="list-style-type: none"> • External pacing via defibrillator • Adrenaline – increase sympathetic drive • Atropine – only used for complete heart block. Blocks parasympathetic. Bradycardia due to hypoxia will stress myocardium • Isoprenaline – chronotrope
<p>Pacing via defibrillator pads</p>	<ul style="list-style-type: none"> • Attach defibrillator pads • Turn defibrillator on and select MANUAL mode – CONFIRM • Switch onto PACER mode • Set RATE and increase OUTPUT to achieve capture • Check pulse to ensure output • To check patient's underlying rhythm, press and hold 4:1 button

Troubleshooting flow chart

If haemodynamic instability, discuss with PICU Consultant +/- Cardiologist

FAILURE TO CAPTURE

FAILURE TO SENSE

