



UNIVERSITY OF OTTAWA
HEART INSTITUTE
INSTITUT DE CARDIOLOGIE
DE L'UNIVERSITÉ D'OTTAWA

Temporary Cardiac Pacing



Objectives

- Outline various types of temporary pacing
- Identify how pacing method determined
- Outline insertion / application procedure for each type of pacing
- Identify initial nursing care required



Temporary Cardiac Pacing

- Temporary cardiac pacing is the application of an artificial electrical stimulus to the heart in the hope of producing a depolarization of cardiac cells.
- It is done when the patients own 'intrinsic' or built in ability to pace fails or to cause a more effective depolarization.



Types of Temporary Cardiac Pacing

- **Transcutaneous pacing** via multifunction pads attached to our Philips Defib machines set on Pacer Mode.
- **Transvenous pacing** via a pacing wire that is inserted thru an introducer in a central large vein into the right ventricle, then attached to a pacer box (pulse generator box) via a pacing cable.
- **Epicardial pacing** (post cardiac surgery) via epicardial pacing wires inserted into the endocardium during cardiac surgery that are attached to a pacer box (pulse generator box) via a pacing cable.



Indications for Pacing

- Any slow rate where the patient is symptomatic
- The slow rate could be:
 - Sinus Bradycardia
 - 2nd or 3rd degree Heart Block
 - Junctional rhythm
 - Idioventricular rhythm
- The etiologies of these rhythm issues could be degeneration of conduction system, atherosclerosis, ischemia, drug induced (OD or antiarrhythmics), conduction issues post cardiac arrest.



Determination of Pacing

- Urgency of need is the prime determination for which pacing method is used.
- Transcutaneous patches are quick to apply, non-invasive, but should only be used for a short time.
- Transvenous pacing should be provided when available: easiest route is right internal jugular or left subclavian; fluroscopy should be used but it can be attempted without it in an emergency
- Obviously, if the patient has epicardial wires post cardiac surgery then this is the primary method of pacing.



Overview of Terminology

Pace	to deliver an electrical impulse
Sense	ability of the pacemaker to detect intrinsic electrical activity
Pacing Spike	stimulus from the pacemaker recorded on the ECG, a short narrow deflection
Capture	depolarization of the heart by an artificial stimulus; patients myocardial cells capture the impulse delivered by the pacemaker; pacer spike followed by a QRS associated with a pulse



Overview of Terminology

Pacing Threshold

Amount of energy required to initiate a depolarization ... for the cells to 'capture' the impulse and depolarize. It is measured in milliamps (MA)

Influenced by:

- Ischemia
- Drugs
- Electrolyte Imbalances
- Pacer wire position



Terminology: Modes of Pacing

Asynchronous (Fixed Rate)

- delivers electrical stimuli at a selected rate regardless of patients intrinsic cardiac activity

Synchronous (Demand)

- delivers electrical stimulus only when needed
- pacemaker detects or “senses” the patients intrinsic electrical activity and inhibits the pacemaker from firing an electrical stimulus



Pacing Device

- Depending on the device being used to pace you may be able to choose:
 - Demand or asynchronous pacing.
 - The rate at which you pace the patient's heart.
 - The amount of energy in milliamps (mA) required for to cause a depolarization in the myocyte, referred to as 'capture'.
 - How sensitive you want the pacer box to be to the intrinsic activity of the heart.

Lets review each of these settings generally before moving on to the specific devices....



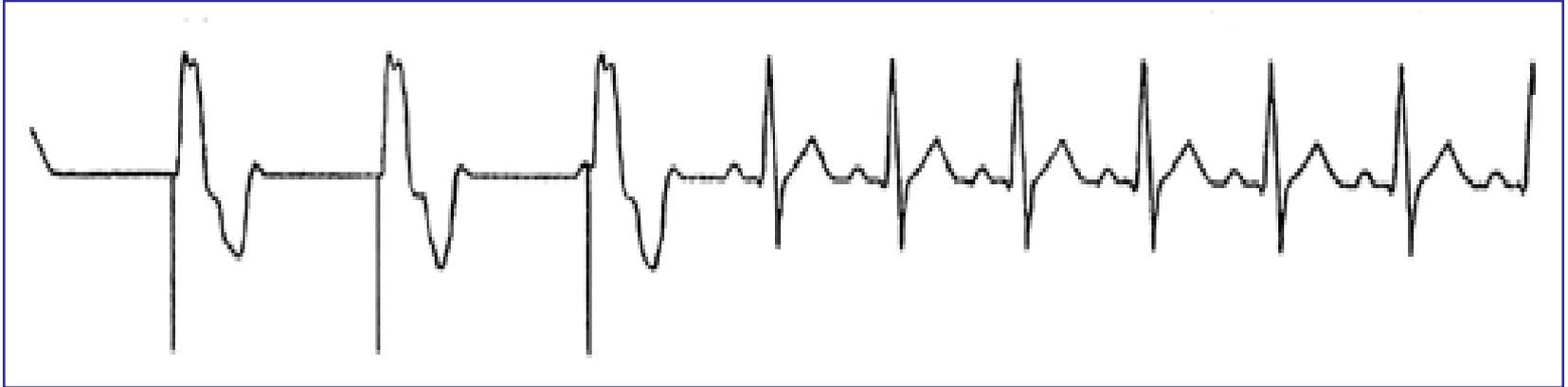
Rates in Demand Mode

Demand (Synchronous) Mode

- In demand mode the stimulus is provided when the patient's heart rate drops below a predetermined rate.
- So if you have the rate of the pacemaker at 60, it won't pace until the patient's heart rate falls below 60.
- The pacemaker box must have adequate sensing for demand mode to work effectively.
- This is the preferred way of pacing as it should avoid competition between the patient's own heart rate and that of the pacemaker box.



Demand (Synchronous) Mode



Pacemaker will emit an output only when there is no intrinsic activity



Rates in Fixed Mode

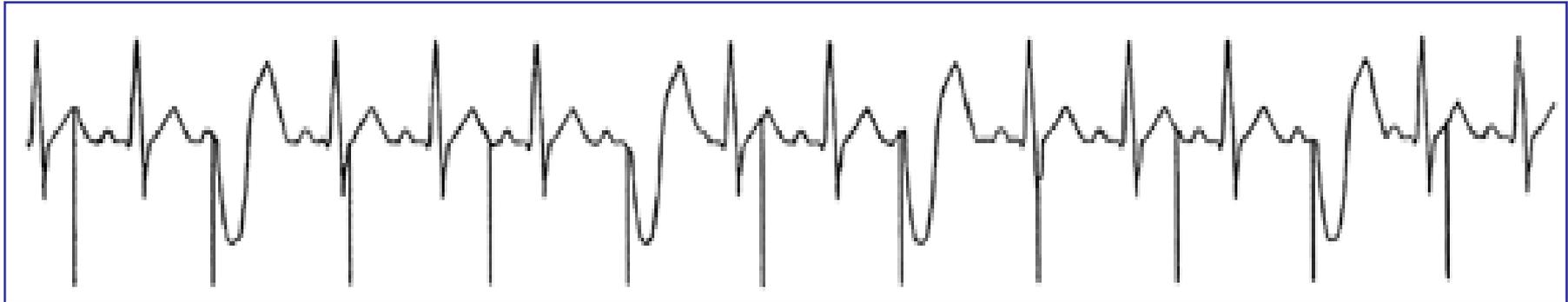
Fixed (Asynchronous) Mode

- In fixed mode the stimulus is provided at a preset rate and the pacemaker fires at that rate regardless of what the patient's heart is doing.
- If fixed rate is used and the patient has an underlying rhythm, the rate must be set greater than the patient's inherent rate to avoid competition
- There is a great risk for 'R on T' phenomena with asynchronous pacing (see Cardiac Anatomy Module 2 for more about 'R on T')



Fixed (Asynchronous) Mode

Pacemaker will emit an output at a fixed rate regardless of intrinsic activity





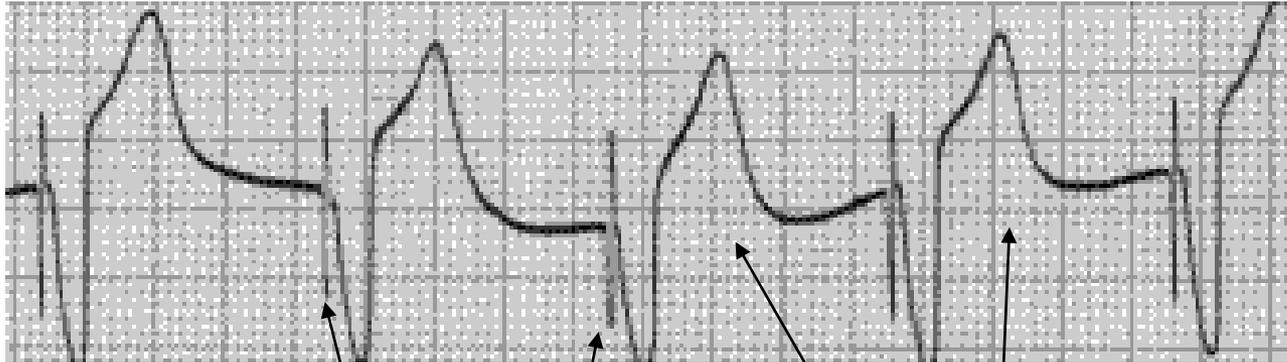
Energy to Elicit Pacing

- The energy used by the pacer box to elicit a depolarization and contraction is measured in milliamps (mA).
- Different hearts may require different amounts of energy to elicit a depolarization and contraction; the variables that could effect the amount of energy required include:
 - position of electrode;
 - contact with viable myocardial tissue;
 - level of energy delivered through wire; presence of hypoxia, acidosis or electrolyte imbalances;
 - other medications being used



Ventricular Pacing

What does a ventricularly paced beat look like?



Pacer Spikes

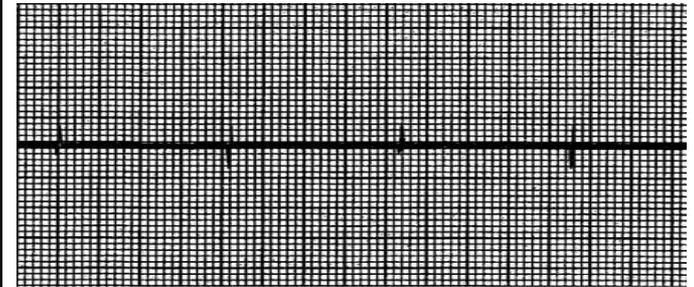
Wide QRS: because the beat is initiated away from the superhighway so it takes longer for the ventricle to depolarize



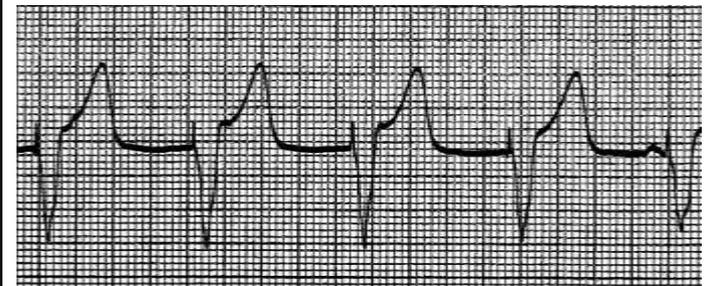
'Capture'

- When there is sufficient energy to cause a depolarization and contraction, it is referred to as 'capture'.
- This strip shows three paced beats followed by the patient's own intrinsic rhythm.

Here is a strip with no underlying rhythm, just pacer spikes. If you saw this you would immediately turn up the mA to try and elicit a depolarization.



Finally, after a couple of seconds the myocytes depolarize ... the cardiac cells have captured the impulse and it is moving through the ventricle....





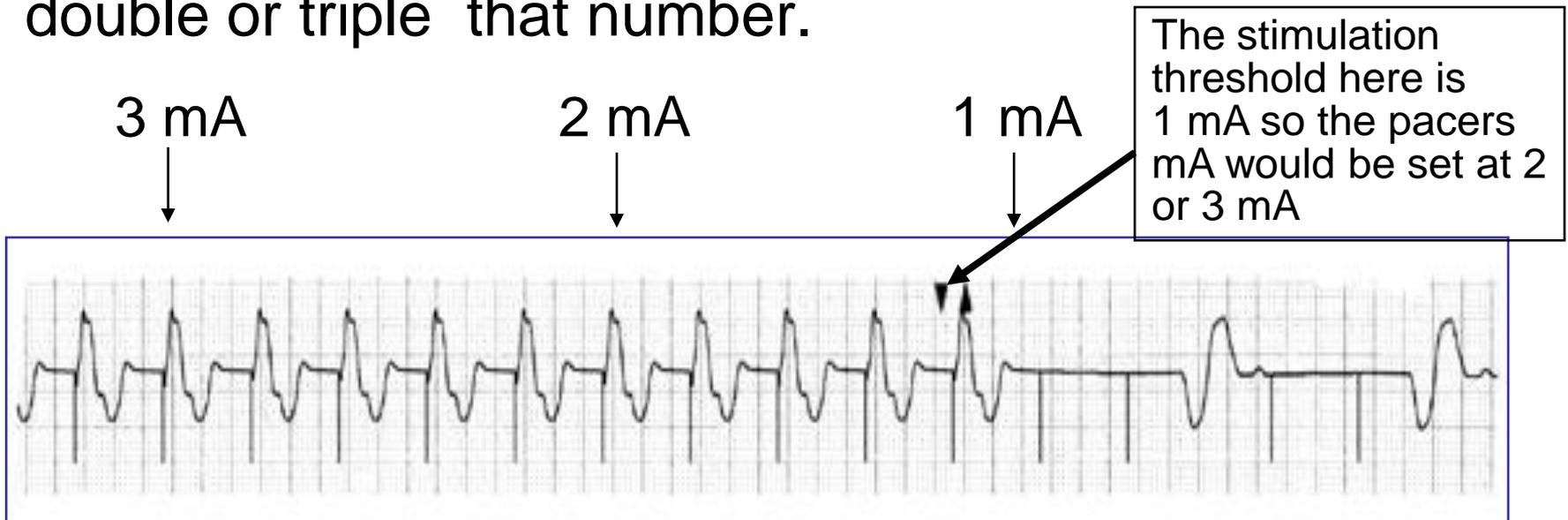
Energy to Elicit Pacing

- The higher the mA the more energy is being generated by the device to try and elicit a depolarization by the cardiac cells.
- If you do not see 'capture' on the monitor then you would turn up the mA.
- You may hear this setting referred to as just 'mA' or 'output' or sometimes 'what are you capturing at'



Stimulation Threshold

- The stimulation threshold is the minimum output pulse needed to consistently 'capture' the heart and cause a depolarization and contraction.
- This should be checked regularly in order to see how much 'leeway' you have to go up in milliamps should it be required.
- Turn the mA down until you no longer have capture ... that is your stimulation threshold .. then set the mA at double or triple that number.



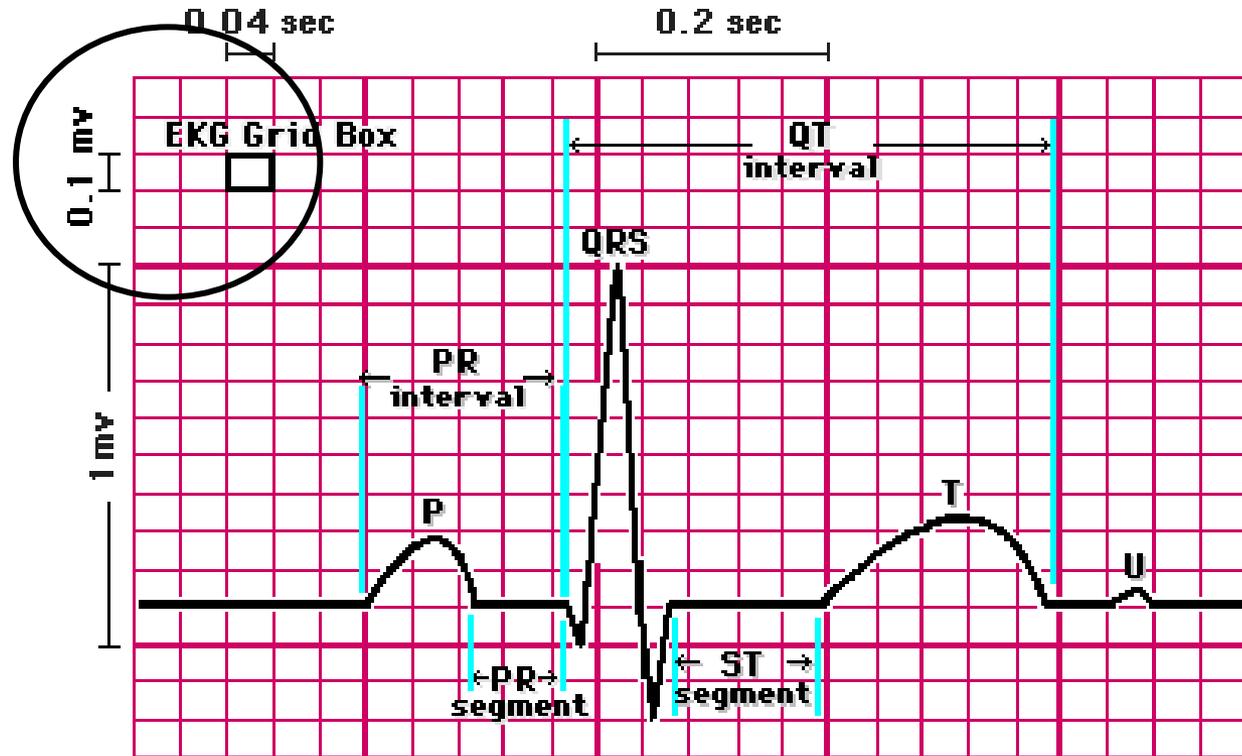


Sensitivity

- Sensitivity refers to the pacing devices' ability to 'see' what electrical activity is being generated by the patients own heart to prevent any competition between the hearts intrinsic activity.
- This allows pacing only on 'demand' when the intrinsic heart rate is too low,
- The energy coming from the heart is measured in millivolts (mV).
- We can actually measure the mV's being produced by the heart on the graft paper our ECG strips are on Each little square is not only 1mm in height but also represents 0.1mV.



Sensitivity





Sensitivity

- So ... we want to set the pacemaker to 'see' even the smallest of electrical activity being produced by the heart so that it doesn't pace inappropriately.
- We set the mV sensitivity on the pacer device to the lowest number so that it will see the smallest amount of electricity being produced by the heart.
- This number will be different depending on which device you are using.

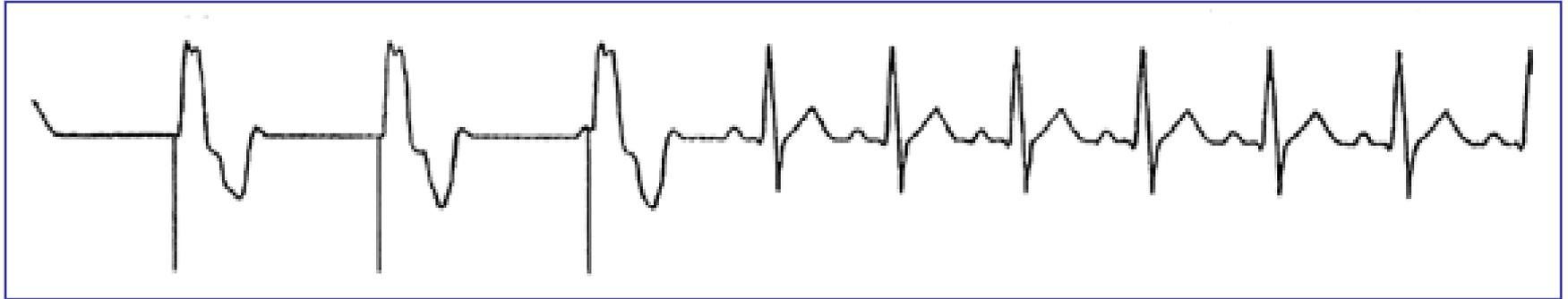


Sensitivity

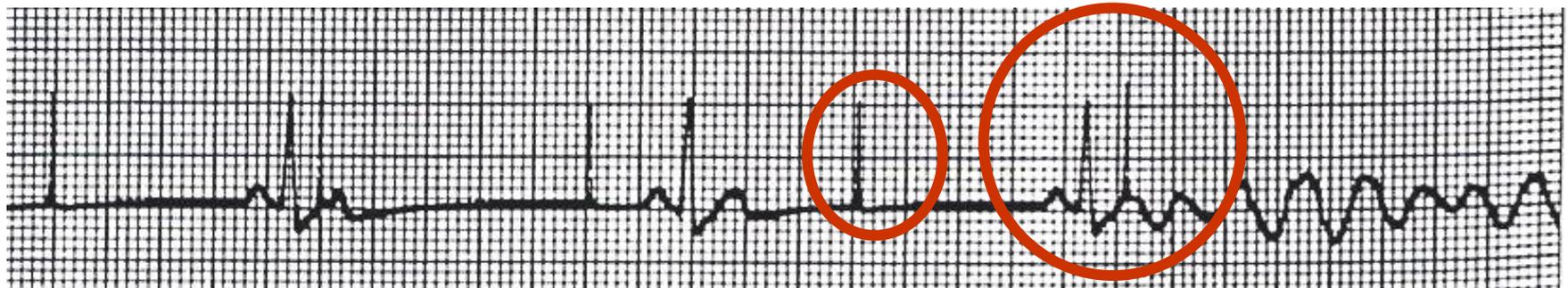
- The sensitivity threshold can be determined by dialing up the sensitivity to find the minimum R wave amplitude needed to be detected by the pulse generator... when you dial up the sensitivity the pacer will start firing inappropriately.
- Once the sensitivity threshold is determined, the sensitivity is set 2-3 times lower.
- However, on a number of the pulse generators it is safest to make the device 'most sensitive'; just turn the dial to the setting at the lowest number which will be labeled 'Demand' mode.



Sensing



- Here the pacer 'sensed' that there was intrinsic activity so did not pace



- Here the pacer is not 'sensing' the intrinsic activity so it is pacing all over the place ... in this case causing VF because it paced on



Remember:

The lower the setting, the more sensitive the pacemaker is to intracardial signals

Lets move on to specific pacing devices

TRANSCUTANEOUS EXTERNAL CARDIAC PACING



Transcutaneous

- External transcutaneous pacing is done in emergency situation.
- Most defibrillators have the ability to deliver this pacing.
- It is very important that you become familiar with your units equipment.





Transcutaneous External Cardiac Pacing

- The Philips Defib machines are capable of delivering either demand or non-demand fixed (asynchronous) pacing.
- You are able to control both the rate and current level (mA), called 'output' on this machine.
- Although it is sensing when you are in Demand Mode, you are not able to control the sensitivity.
- Pacing is done thru two disposable electrodes which are self adhering.



Transcutaneous External Cardiac Pacing

Equipment required

- Multifunction pads (same ones which are used to defibrillate, cardiovert, and pace).
- Connection cable for the pacing pads
- ECG signal:
 - 3 or 5 lead ECG cable
 - synchronization ECG cable to plug into the monitor
- The ECG signal must be attached to the defib machine for you to see what the patients ECG rhythm is ... the machine will not pace and give you an ECG signal thru the pads at the same time.

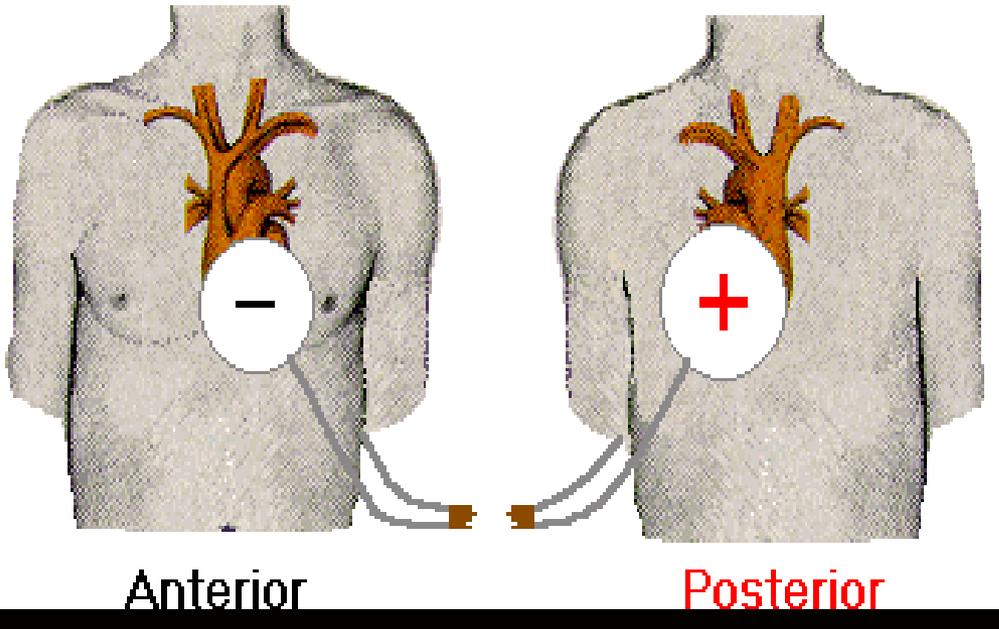


Transcutaneous External Cardiac Pacing

- Labeling of patches varies by manufacturer
- Positioning of patches can be as per manufacturers pictures on patches or anterior posterior ... if you are doing CPR it may be easier to apply anterior.
- Skin should be clean, dry, & intact
- Clip hairy chest PRN
- Once you have positioned the pads so that you have good sense and capture ... leave them there.... however if you have to leave the pads on for an extended time, change pads Q12 hours (theoretically, if a patient requires transcutaneous pacing for more than a short time (say 60 -120 mins or so), a transvenous wire should be inserted).



Application: If applying anterior/ posterior



- The anterior patch is placed on the left anterior chest halfway between the xiphoid process and the left nipple
- Posterior electrode is placed on the left posterior chest beneath the scapula and lateral to the spine



Application: If applying anterior/ posterior

If applying anterior/anterior follow the instruction pictures on the pads themselves.

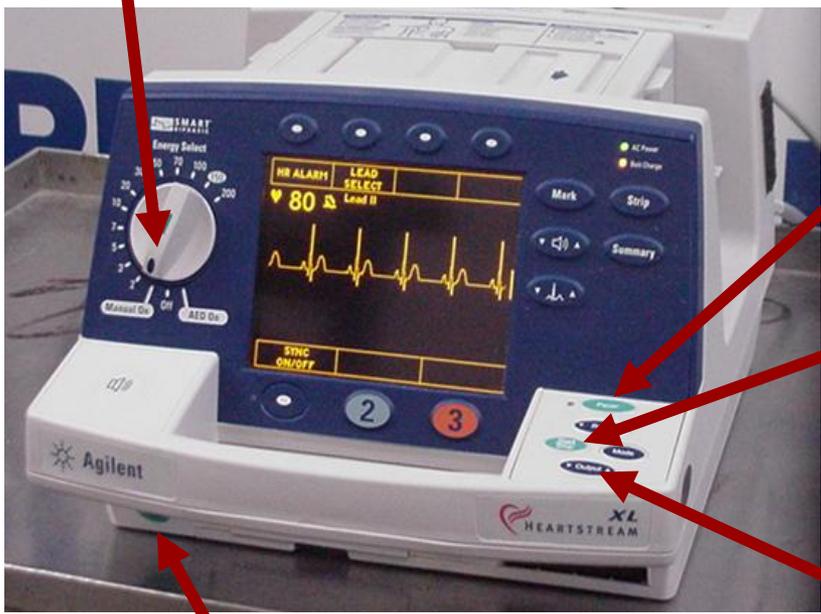


Remember to plug sync cable or ECG leads into Defib machine

Comes 'on' in Demand mode so needs sync cable to 'see' rhythm
If sync cable unavailable change mode to 'fixed' if patient asystole

1. Turn the defib machine to manual and plug in appropriate cable

2. Turn Pacer modality on



Special multifunction pad cable is inserted here

3. Press start

4. Increase mA until you have a pacer spike, followed by a QRS associated with a pulse





Transcutaneous External Cardiac Pacing



- When you turn on the pacer modality, the machine will automatically come on with a rate of 70 and a mA of 30.
- If there is no capture after pressing 'start', increase the 'output' until the pacemaker 'spikes' result in consistent 'capture' of the ventricle and there is an associated pulse.
- Output can go as high as 200 mA (because it has to travel thru so much tissue³⁵)



Transcutaneous External Cardiac Pacing

- Each pacer spike on the monitor should be followed by a QRS.
- The QRS will be wider than normal because the paced beat is traveling off the 'conduction highway' so it takes longer as it travels thru the ventricle cell to cell to cell.
- Once you see a pacer spike, followed by a QRS check the femoral pulse to ensure that the QRS that you see is actually producing a cardiac cycle.
- There is significant discomfort for the patient so ensure analgesia has been ordered.





Transcutaneous External Cardiac Pacing

- We cannot stress enough the need for you to be familiar with the equipment required for transcutaneous pacing.
- It is your responsibility to take a few minutes once a month to run thru the set up ... plug in the required cables, practice running thru the settings.
- This way when pacing is required in an emergency, you know exactly what to do to save your patient next time they loose their heart rhythm!!!

It only takes 4 minutes of no cardiac output to start loosing brain cells Knowing what to do could make all the difference to that patients future.



Pulse Generators



- These are the pulse generators used at UOHI.
- They are all dual chamber.



Pulse Generators

- Pulse generators are small, battery-powered medical devices designed to electrically stimulate the heart muscle in an effort to restore a heart rhythm or increase the rate of a heart rhythm.
- At UOHI all pacemakers are the same and have the capability of pacing either the atria or the ventricle or both the atria and ventricle.
- Pulse generators are generally referred to as 'pacer boxes'.
- They are used with either transvenous or epicardial pacing wires in situ.



Pulse Generators

- With these pacemaker boxes you can choose and adjust:
 - Asynchronous or demand pacing.
 - The rate at which you pace the patient's heart.
 - The amount of energy in milliamps (mA) required for to cause a depolarization in the myocyte, referred to as 'capture'.
 - How sensitive you want the pacemaker box to be to the intrinsic activity of the heart.



Pulse Generators



Use the dials to set:

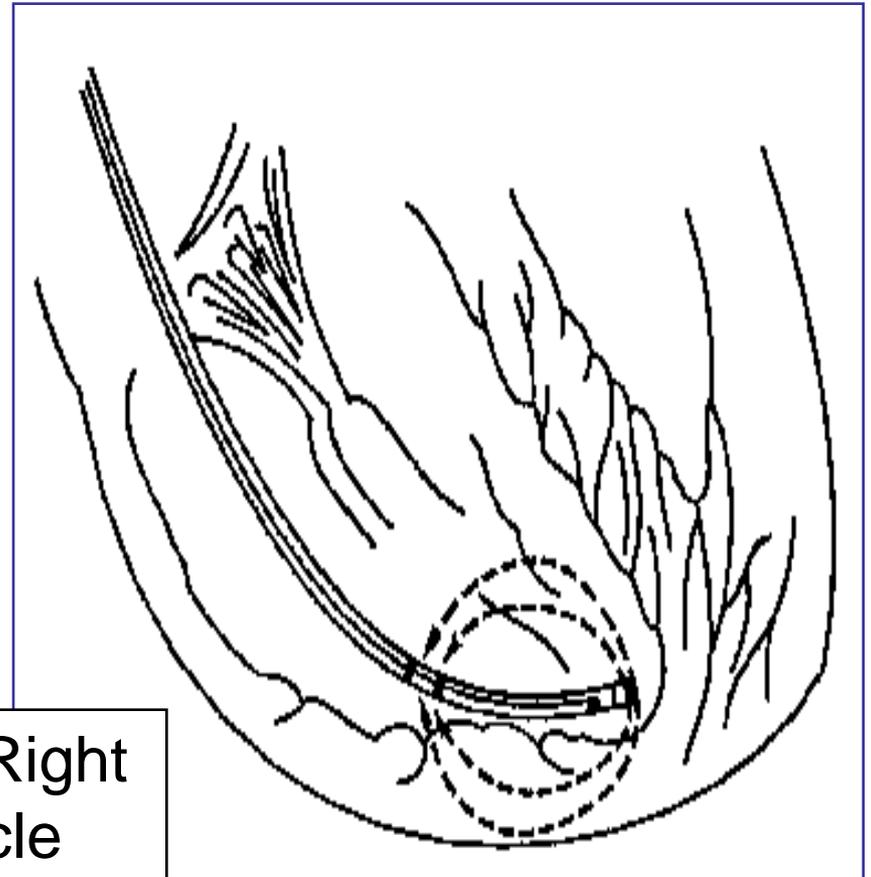
Rate

mA (atrial and ventricular)

Sensitivity



Transvenous Wires



Lead in Right
Ventricle



Transvenous Wires

- Transvenous wires are inserted thru an introducer placed in a large central vessel such as the jugular or femoral veins (try and stay away from subclavian because the EP guys might need it for access for a permanent pacer).
- It is imperative that the right size introducer be used for the right size of transvenous wire ie a size 5 fr. wire goes into a 6 fr introducer; a 6 fr wire thru a 7 fr introducer etc.
- Do not put a 5 or 6 fr wire down an introducer which has had a PA catheter in it There will be leakage around the wire into the protective sterile sheath because the previous catheter thru the introducer was considerably larger.



Insertion of Transvenous Wire

- This procedure can be done with a number of different bipolar leads ... some have balloons to help them float into place, some are what are called 'hard wires'.
- The best way to ensure proper placement is to do the procedure under fluoroscopy, but if transvenous pacing is required stat it can be inserted without fluoroscopy.
- The MD can estimate the length required from the site of entry to the right ventricle prior to beginning the insertion of the lead by 'measuring' up the patient this just helps the MD have an idea of where they should be during the insertion.



Insertion of Transvenous Wire

- Gather equipment:
 - pacing lead, pacer box & connecting cable
 - skin prep solution
 - introducer kit
 - gowns, masks, gloves
 - sutures, syringes, & needles
 - suture tray & scalpel blade
 - Defibrillator
- Make sure you save the sterile sleeve for the lead from the introducer set kit And make sure the doc remembers to put it on the pacer wire!!!!



Insertion of Transvenous Wire

- MD will insert the appropriate sized introducer.
- Under sterile conditions provide the MD with the pacing lead.
- They then need to apply the sterile sleeve over the lead (the sterile sleeve was in the introducer kit).



- MD will hand you the connector end of the pacer lead for you to connect to the pacer box. Remember to attach the leads appropriately, positive to positive; negative to negative.



Insertion of Transvenous Wire

- Set to pacer box to a rate of 10 and most sensitive.
- As the MD advances the lead watch both the rhythm on the monitor and the sensing light on the pacer box... if the patient has an underlying rhythm, as the lead comes in contact with the endocardium the sense light will flash when there is intrinsic activity ... so you know the lead is near cardiac structure.
- Once the lead has reached the right ventricle and is properly positioned, check the stimulation threshold (you may need to increase the rate above the intrinsic rate if the patient has one).



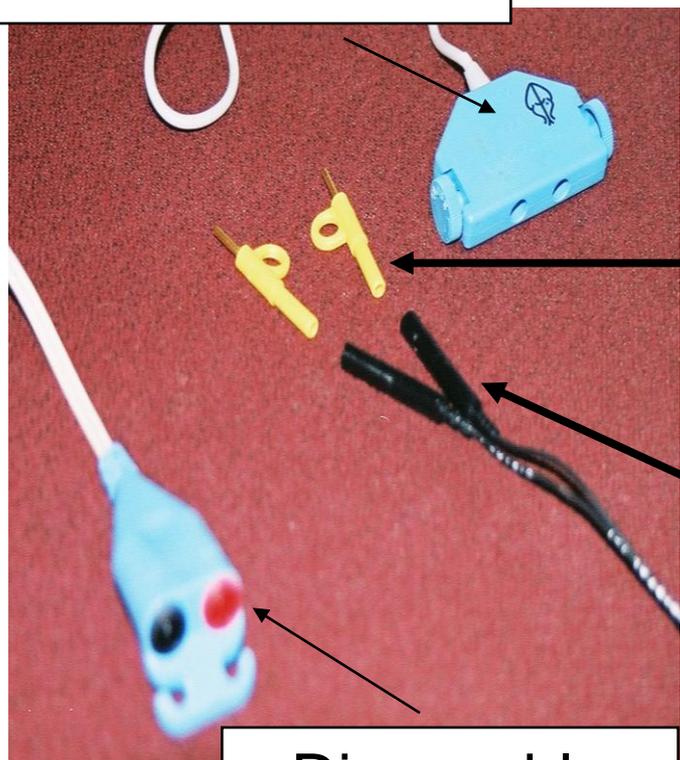
Insertion of Transvenous Wire

- The wire then needs to be well secured.
- How much can you move the patient with a transvenous wire?
 - Depends on the patient ... sometimes you can sit them on the side of the bed and you won't lose sense or capture ... sometimes you have issues with the wire moving just turning the patient.
 - Best advice is to always move the patient with extreme care, watching the monitor and always be prepared for the worse case scenario!!!



Connection Cables for Transvenous Wires

Non-disposable
/ block cables



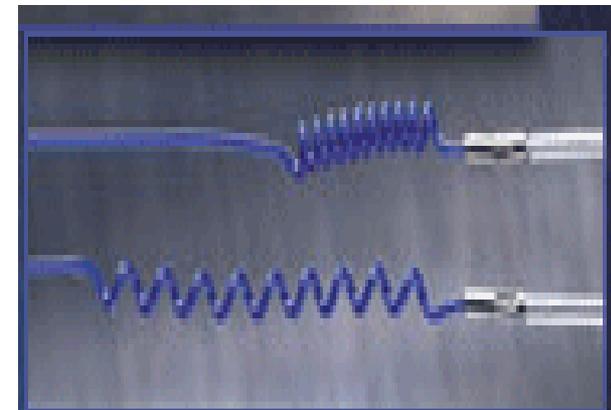
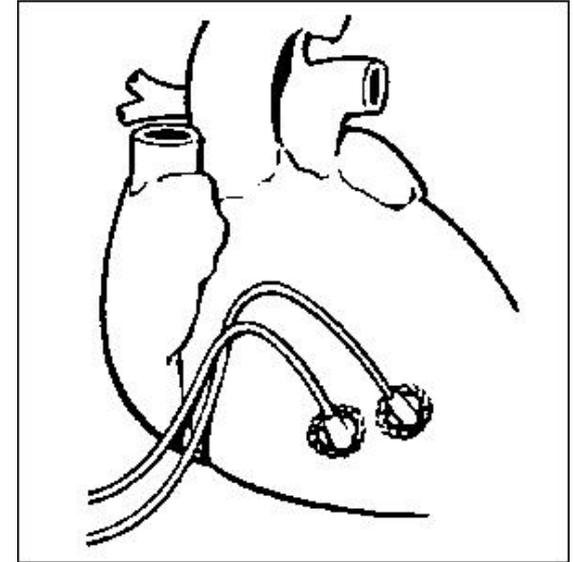
Disposable
cables

- At UOHI you may see different cables for the transvenous wires ... other TOH sites use a disposable cable so the patient could arrive to our units with it attached to a transvenous wire.
- The non disposable cables we usually use require the 'peg' ends attached to the pacer wire.
- Remember if the wire is marked:
 - Distal = negative
 - Proximal = positive
- When going into the cable negative to negative and positive to positive



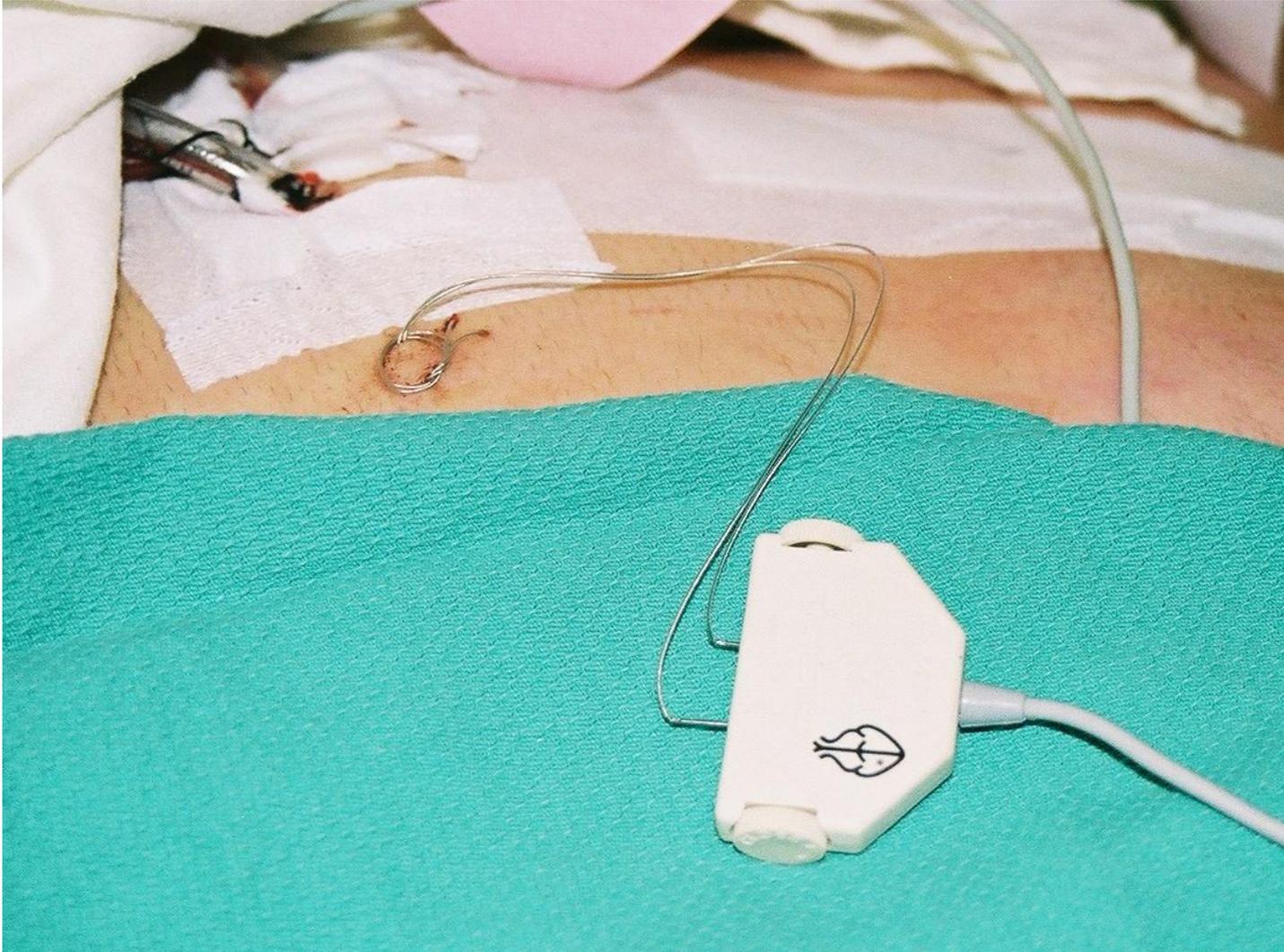
Temporary Epicardial Pacing

- Epicardial pacing is done thru small wires placed in the myocardium during cardiac surgery.
- The wires are placed in either the right atria or the right ventricle (or both) and kept in place in the heart by a coiled portion in the wire.





Temporary Epicardial Pacing





Temporary Epicardial Pacing

- How you connect the wires to the block cable depends on how many wires you have.
- If you have two wires ... each wire goes into an opening of the block lead.
- If you have one wire, you need to insert a ground wire to act as the positive end of the circuit then the ground wire is inserted into the positive access of the block cable.
- If you have atrial wires and ventricular wires, each set needs its own block cable.
- Always use a ground wire, never borrow a wire ie don't use a ventricular wire as a ground for atrial pacing and visa versa.



Temporary Epicardial Pacing

- Once the pacer wires are attached to the block lead take a clean glove ... turn it inside out enough that it forms a pocket Put into the pocket the connection portion of the block lead and the pacer wires.
- Tape the glove to the patients skin using just two pieces of tape ... **DO NOT PUT TOO MUCH TAPE OVER THE GLOVE** ... too much tape makes it difficult to assess the status of the wires / block lead in an emergency.



So

- We have attached the pacing wire (either transvenous or epicardial) to the pulse generator....
- We have set the rate as ordered (if it was an emergency and you have followed the pacemaker directive the rate will be 80)
- Set the mA so that there is good capture ... we can see a pacer spike that is followed by a QRS and a contraction.
- Set the sensitivity on demand so there is good sensing.
- Now we will review the pacemaker codes that help us recognize what type of pacing is going on.



NASPE Codes

- The **N**orth **A**merican **S**ociety of **P**acing and **E**lectrophysiology (NASPE) has developed a code so that when we are talking about what the pacers are set at, everyone is talking the same language.
- Each 'position' or letter represents
- For temporary pacing we use the first three letters of the code, permanent pacers use 5 letters.
- The chart on the next slide shows all 5 letters, just so you have a resource for when you have a patient with permanent pacer.



NASPE Codes

I	II	III	IV	V
Chamber(s) Paced	Chamber(s) Sensed	Mode(s) of Response	Programmable Functions	Antitachycardia Functions
V= Ventricle	V=Ventricle	T=Triggered	R=Rate Modulated	O=None
A=Atrium	A=Atrium	I=Inhibited	C=Communicating	P=Paced
D=Dual (A&V)	D=Dual (A&V)	D=Dual Triggered & Inhibited	M=Multi- programmable	S=Shocks
O=None	O=None	O=None	P=Simple Programmable	D=Dual (P&S)
			O=None	



NBG Codes – 3 Letter Temporary Code

1st Letter

Chamber(s) Paced

A = atrium

V = ventricle

D = dual (both atrium and ventricle)

2nd Letter

Chamber(s) Sensed

A = atrium

V = ventricle

D = dual

O = none

3rd Letter

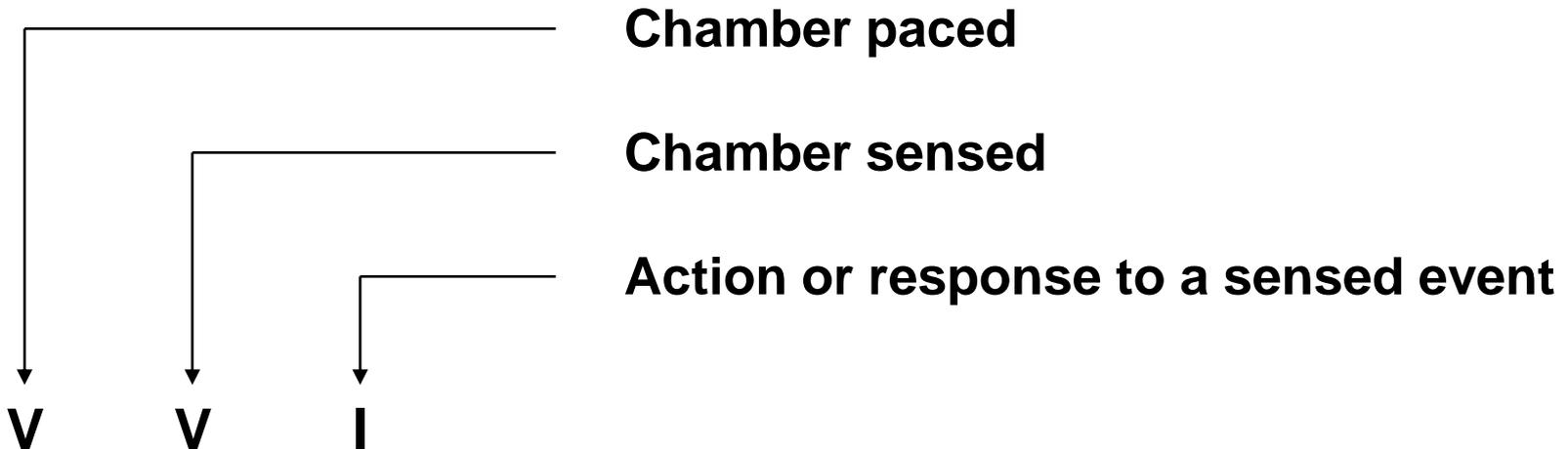
Response to Sensing

I = inhibit (Demand mode)

T = triggered

D = dual

O = none (Asynch)





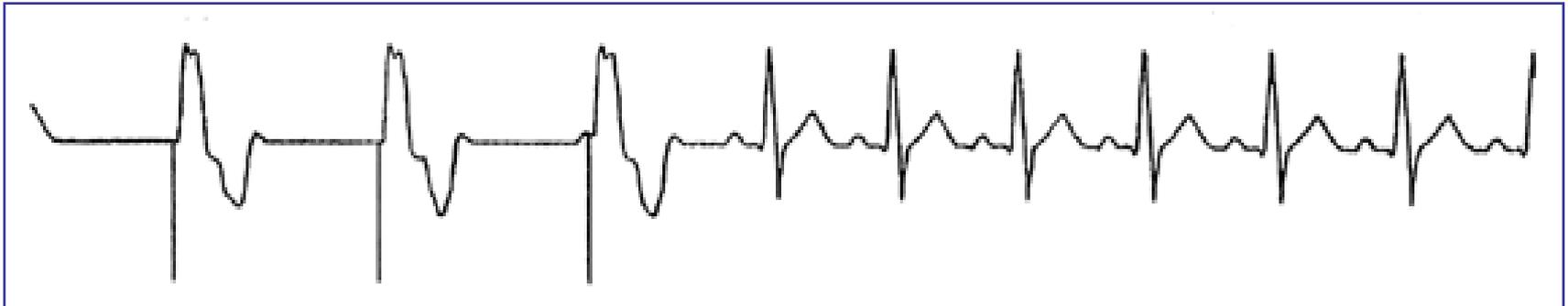
Commonly Used Pacemaker Modes

- You are told in report that your patient has a transvenous wired and it is pacing **VVI** at a rate of 80 What does that mean?
 - **V** – Ventricular pacing: the pacing device is located in the **ventricle**
 - **V** – Ventricular sensing: sensing for **ventricular** activity
 - **I** - Inhibit mode: the pacing device will **inhibit** itself from pacing when it sense intrinsic ventricular activity



VVI Demand/Inhibited

- Here the pacing device paces the heart when the patient's own rate becomes slower than the rate set on the pacemaker.
- When the pacemaker senses intrinsic depolarization it stops pacing.





Commonly Used Pacemaker Modes

- You are asked to hook up the patients atrial wires because their blood pressure is low ... the hope is by increasing 'atrial kick' by pacing the cardiac output will increase and the blood pressure will go up The order is to set the pacer at **AAI** rate of 80.
 - **A** - Atrial pacing: the pacing device is located in the **atria**
 - **A** - Atrial sensing: the device is sensing for **atrial** activity
 - **I** - Inhibit mode: the pacing device will **inhibit** itself from pacing when it senses any intrinsic atrial activity



Try this one

- VOO
 - 1st letter is
 - Where is it pacing?
 - Ventricle
 - 2nd letter is
 - Is it sensing Is it?
 - No
 - 3rd letter is
 - Is the pacemaker inhibiting itself from pacing when there is an intrinsic beat?
 - No

VOO is fixed asynchronous pacing of the ventricle ... the pacemaker doesn't care what the patient's heart is doing it is just going to pace at the set rate.



DDD

- DDD pacing is done when there are atrial and ventricle wires ... so you will see it post cardiac surgery or with permanent pacing.
- **D** – pacing in both the atria and ventricle
- **D** – sensing in both the atria and ventricle
- **D** – dual functionthere will be both inhibition of pacing when there is intrinsic activity and there will be triggering we'll cover that in the next slide...

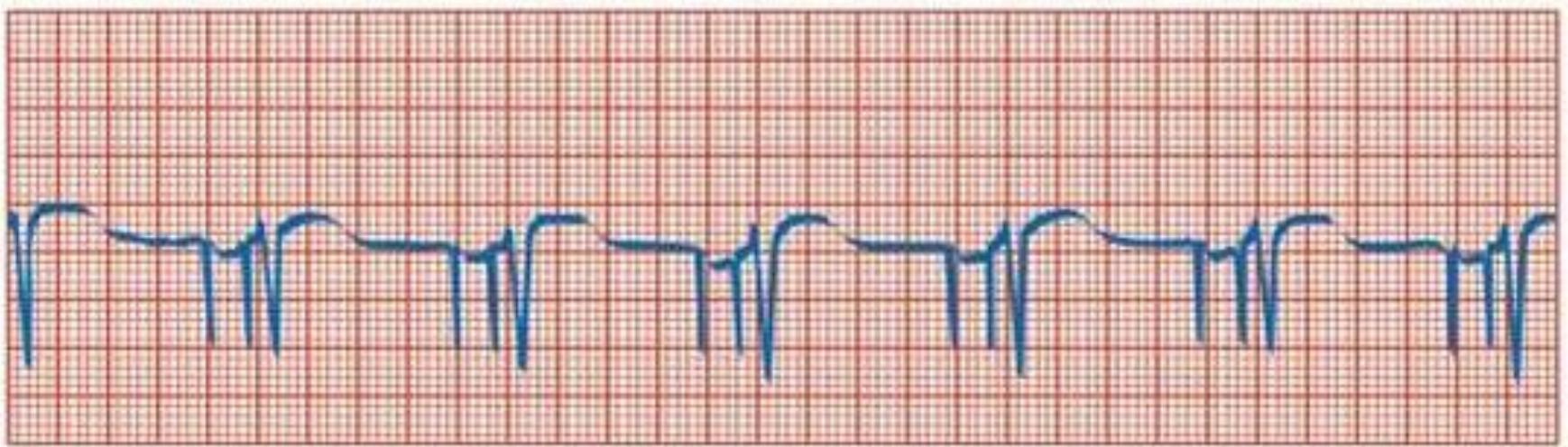


Triggering in DDD pacing

- DDD is a form of AV synchronous pacing
- Hemodynamically the patient will be much better off if the atria and ventricle depolarize in an organized manner ... the atria depolarizing prior to the ventricle depolarizing.
- So in DDD pacing, if the rate is set higher than the intrinsic rate, you will see a small pacing spike in front of a P wave If after a preset time period, called the AV interval, there is no ventricular activity sensed, the pacer will also pace the ventricle.



DDD Pacing



Here you can see an atrial pacer spike and a ventricular spike DDD pacing ..

The pacemaker sensed it needed to pace atrially... then waited the set AV interval (sort of the PR interval) ... there was no ventricular activity so it paced the ventricle too.



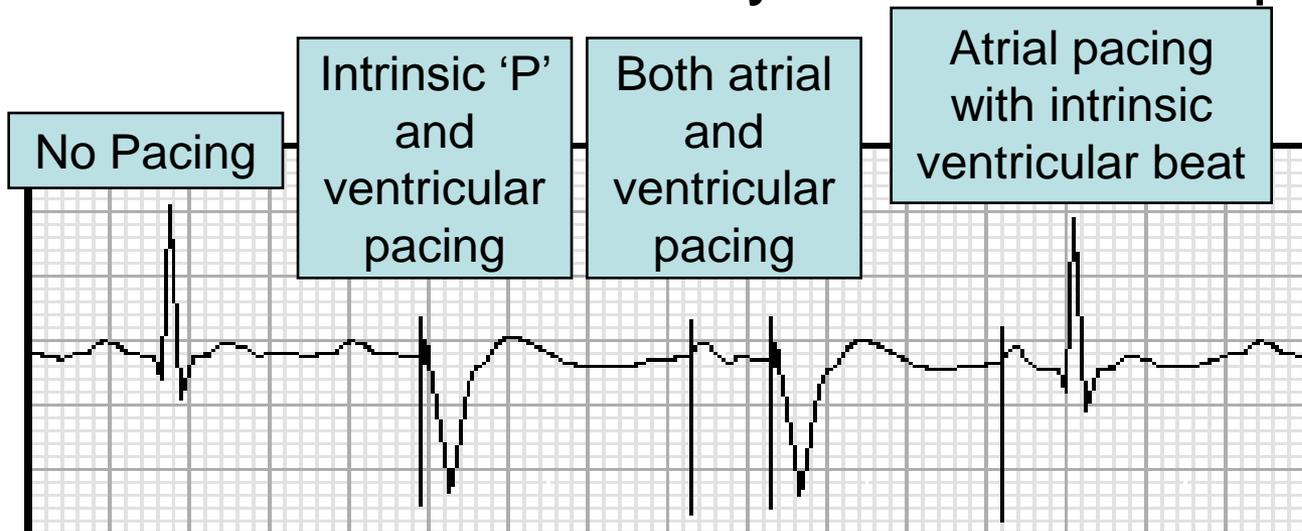
Other DDD Scenarios ...

- Pacer set on DDD rate of 80
 - Patients own atrial rate is 88
 - What will the pacer do first
 - It will **SENSE** that the atrial rate is higher than the set rate so it will not pace the atria
 - The pacer will then wait the preset AV interval and see if the patients ventricle depolarizes at the rate of the atria....
 - If the ventricle does not depolarize, the pacer will be **TRIGGERED** to pace the ventricle but....
 - **IT WILL PACE THE VENTRICLE AT THE INTRINSIC RATE OF THE ATRIA ... 88 bpm**



Other DDD Scenarios ...

- This 'atrial tracking' allows the heart to work in synchrony, the ventricle depolarizing at the same rate as the atria.
- Another scenario is when the intrinsic atrial rate is lower than the set rate ... so the atria is paced but after the AV interval an intrinsic ventricular depolarization occurs ... so the pacer **SENSES** that there is ventricular activity so it does not pace.



Troubleshooting



To help prevent the need to troubleshoot ...

Lets start troubleshooting by talking about what you should be doing at the beginning of **every shift** to help minimize the troubleshooting you will have to do!

1. Assess the wires involved –
 - a. is the temporary transvenous wire well secured;
 - b. sort out which epicardial wires / ground wires are actually attached to the pacer ... you may have to unwrap the wires / pacer cable from a glove but it is important you know what you are dealing with.



To help prevent the need to troubleshoot ..

2. Check the pacer box ...
 - a. what are the pacer settings: rate, mA, mV
 - b. Determine the mode Is it VVI, AAI, DDD?
 - c. CHECK THE BATTERY... look at the number of bars remaining, **if 2 or less OR if battery is flashing, then change batteries immediately.**
 - d. Check that the cable/s are well secured into the pacer box.
 - e. If the patient is pacer dependent always make sure there are spare batteries in the room.





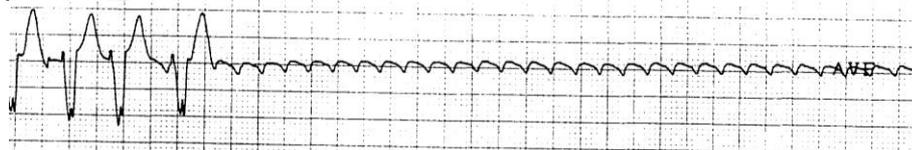
To help prevent the need to troubleshoot ...

3. Check the ECG strip ...
 - a. What is the rate of the rhythm on the ECG strip ... compare that to the rate set on the box ... should the rhythm be paced or intrinsic.
 - b. Is the pacer capturing every pacer stimuli?
 - c. Is the pacer sensing all intrinsic activity?



To help prevent the need to troubleshoot ...

4. Check the underlying rhythm and mA threshold (**CSICU RN 's**).
- a. Do this on day shift when there is plenty of staff around (just in case it doesn't work as planned!)
- b. To check underlying rate slowly turn down the rate on the pacer **DO NOT JUST PULL OUT THE PACER CABLES OR USE THE PAUSE BUTTON** ... you need to 'walk the rate' down to give the intrinsic rate a chance to evolve. Personally if I get down to 30 bpm that is as low as I go ... run a strip to see what the underlying is and then dial back up.





To help prevent the need to troubleshoot ...

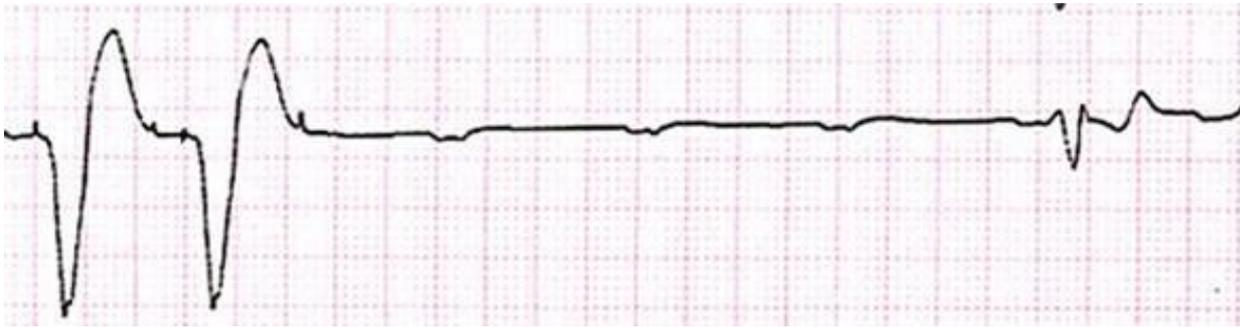
- c. To check mA threshold turn the rate of the pacer to around 10 beats above the intrinsic rate ... then turn down the mA until you loose capture ... then double or triple that number.

By doing your shift checks it will help having to troubleshoot But just in case we will cover the some potential issues in the next few slides.



Failure to Pace

- With failure to pace, the pacer does not produce a stimulus when it should.



When you have 'failure to pace' you should check for :

- Failure of pacemaker battery or pulse generator so change both out
- Loose cable connections in the pacing system
- Fracture or dislodgement of the pacing lead wire
- With epicardial pacing, check ground is in place⁷³



Failure to Pace

- What if you can't get the pacer going and the patient is asystole !!!
 - Call for help ... if you have no cardiac output someone will need to start CPR.
 - Call for a new cable and box and try changing them out.
 - Get the defibrillator in the room and assign someone to set up for transcutaneous pacing.
 - If you are dealing with epicardial wires strip everything down so you can see the wires / ground wire while you are working with them.

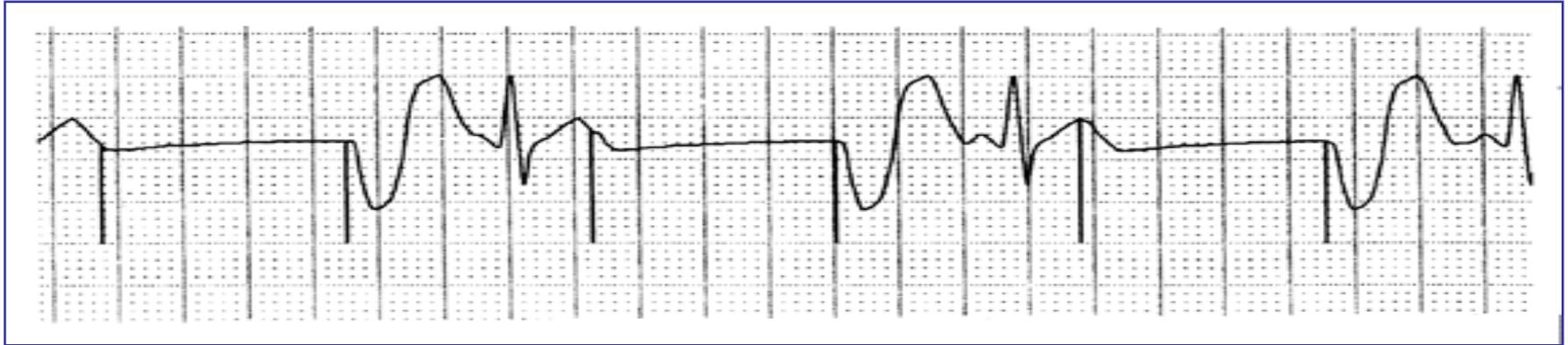


Undersensing

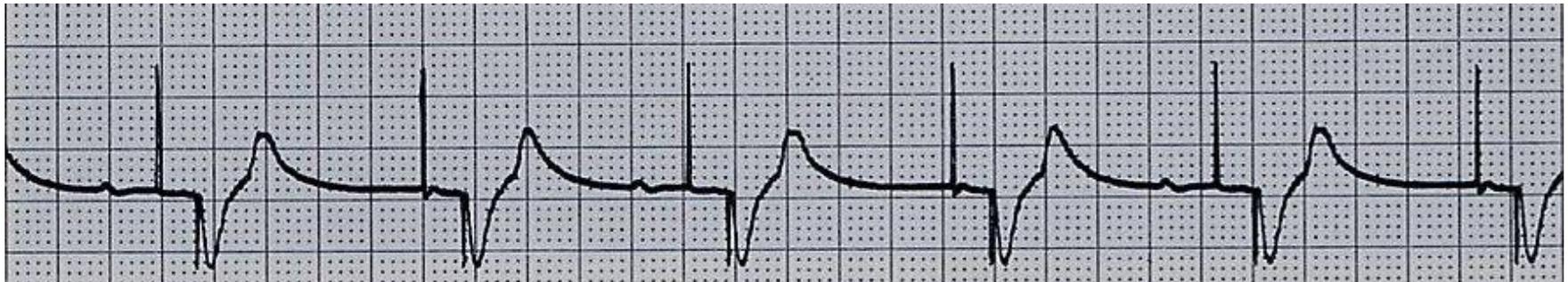
- When a pacemaker 'undersenses' it fires with no regard to the patient's own rhythm. It doesn't sense the intrinsic activity of the patient's heart.
- This can be dangerous with ventricular pacing because it may lead to ventricular tachycardia and/or ventricular fibrillation especially in the presence of existing electrolyte imbalance or cardiac irritation.
- Undersensing can occur because of inadequate QRS signal, myocardial ischemia, fibrosis, myocardial edema, electrolyte imbalances, bundle branch block, or a poorly positioned lead.



Undersensing



The above is an example of ventricular undersensing There are some paced beats but also pacer spikes inappropriately in intrinsic activity.



The above is an example of atrial undersensing There are some paced beats but also pacer spikes inappropriately in intrinsic activity.



What do we do about undersensing?

- First check to see what the sensitivity is set at ... remember the lower the number the more sensitive the pacer is ... if the pacer can be made more sensitive then do so.
- Check that the battery light is not on.
- Check all lead connections If you are using epicardial wires with a ground make sure the ground remains implanted in the skin.
- If it is a transvenous lead turn the patient on their left side until repositioning can be done.
- Switch polarity on epicardial wires
- If the patient has an adequate underlying rhythm, you may have to turn the pacer off.



Oversensing

- When oversensing occurs the pacemaker thinks it detects a QRS complex so it inhibits itself from producing a pacing stimulus.
- What the pacer could be seeing is:
 - Tall or peaked P waves or T waves
 - Myopotentials (electrical signals produced by skeletal muscle contraction as with shivering or seizures)



Oversensing



Should have paced here but the pacer saw the myopotentials as intrinsic activity so didn't fire.

- If you see oversensing, you need to make the pacer less sensitive ... increase the mV.
- Check all connections, change cables, switch pacer
- Reverse polarity on epicardial wires



Failure to Capture

- Failure to capture is when the cardiac cells are unable to depolarize in response to the stimulus being generated by the pacemaker.
- It could happen because:
 - there is not enough milliamps (mA) being generated by the pacer for the cells to depolarize.
 - The cells are unable to depolarize because of issues such as ischemia, fibrosis, electrolyte imbalance, the lead has perforated the myocardium
 - There is an issue with the pacing system



Failure to Capture

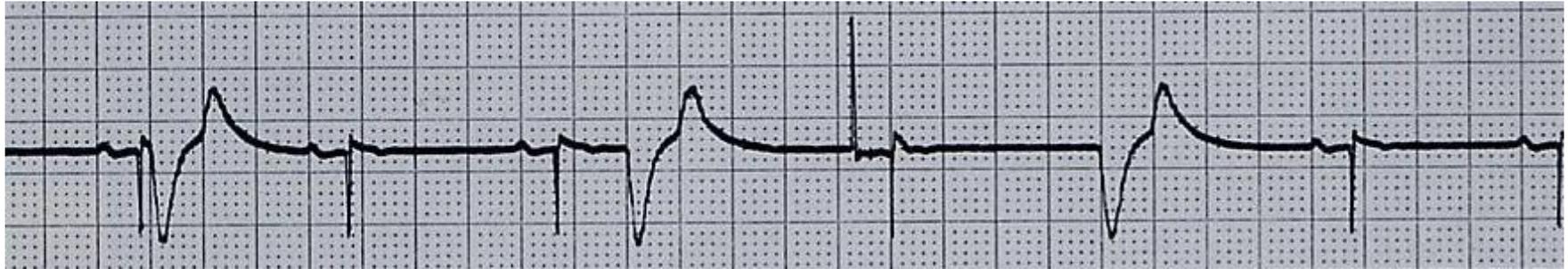


Failure to capture

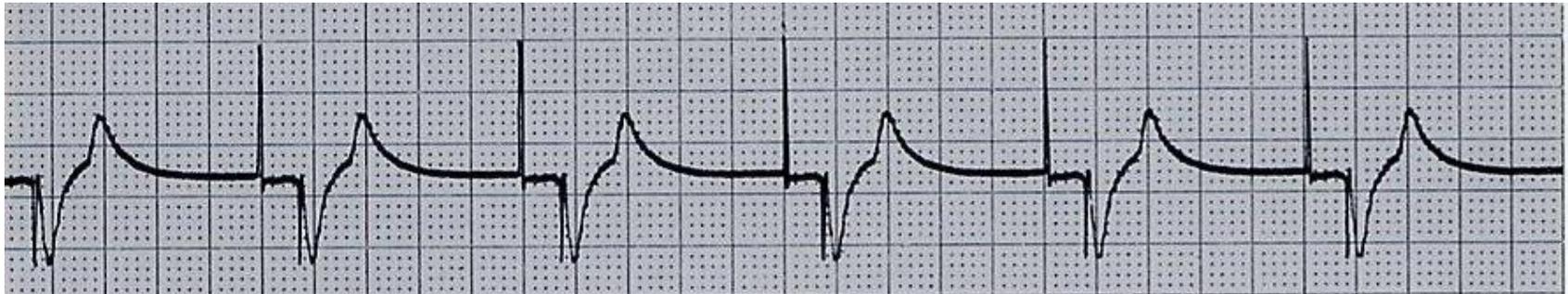
- Here you can see two ventricular paced beats followed by failure to capture of ventricular pacing ... pacer spikes with no QRS associated with it.



Failure to Capture



- This is an example of failure to capture in DDD pacing where both the atria and ventricle are not being depolarized by the pacer stimuli



- This is an example of failure to capture the atria in DDD mode. You can see an atrial pacer spike but no 'p' wave... ventricular pacing is fine.



Failure to Capture

- When you have to deal with failure to capture you need to:
 - Check to make sure the battery light on the pacer is not on ... change battery if required
 - Increase the mA
 - Check and change the lead cables, connections and the pacer itself ... if dealing with epicardial wires ensure the ground is insitu
 - If you have a transvenous wire it may need to be repositioned.
 - Try changing polarity (change which wire is in the positive and negative port).



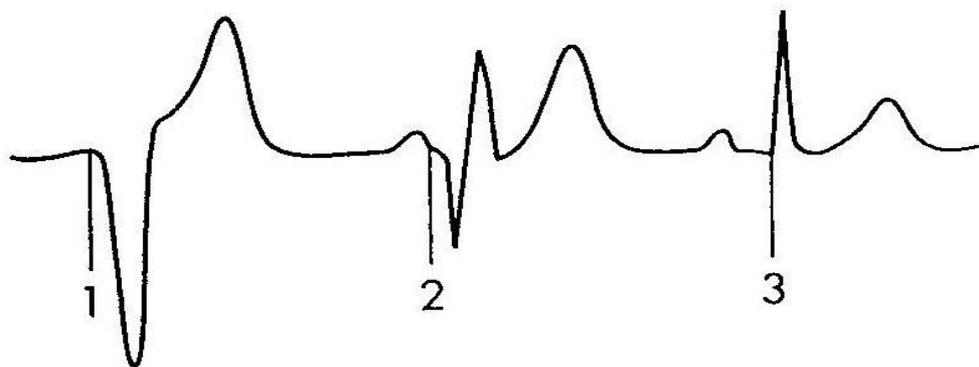
Competition

- There will be times, especially if the heart is recovering when both the intrinsic rate and the paced rate are very close.
- This can lead to competition between the two.
- You can also competition when there is:
 - Asynchronous pacing
 - Failure to sense
 - Mechanical failure: wires, bridging cables, pacemaker
 - Loose connections



Competition

- If the patient has an adequate underlying rate and rhythm it may be wisest to turn the pacer rate down to prevent fusion beats



1 is a paced beat

2 & 3 are fusion beats



Permanent Pacemakers (PPM)

Permanent pacers are dealt with in a separate presentation but lets review a couple of issues that come up in daily practice:

- If you defib a patient with a perm pacer the paddle should be at least 10 cm away from the 'can' (the 'can' is the part of the device under the skin that hold the battery etc) of the device.
- Some PPM are set to have a lower rate at night to mimic natural circadian rhythm.
- Always give the pacer clinic a call to obtain a report of what the PPM is set at ... best to have this information on the chart.