MANAGING TEMPORARY EPICARDIAL PACEMAKERS WITH CONFIDENCE

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- No disclosures
- No COI

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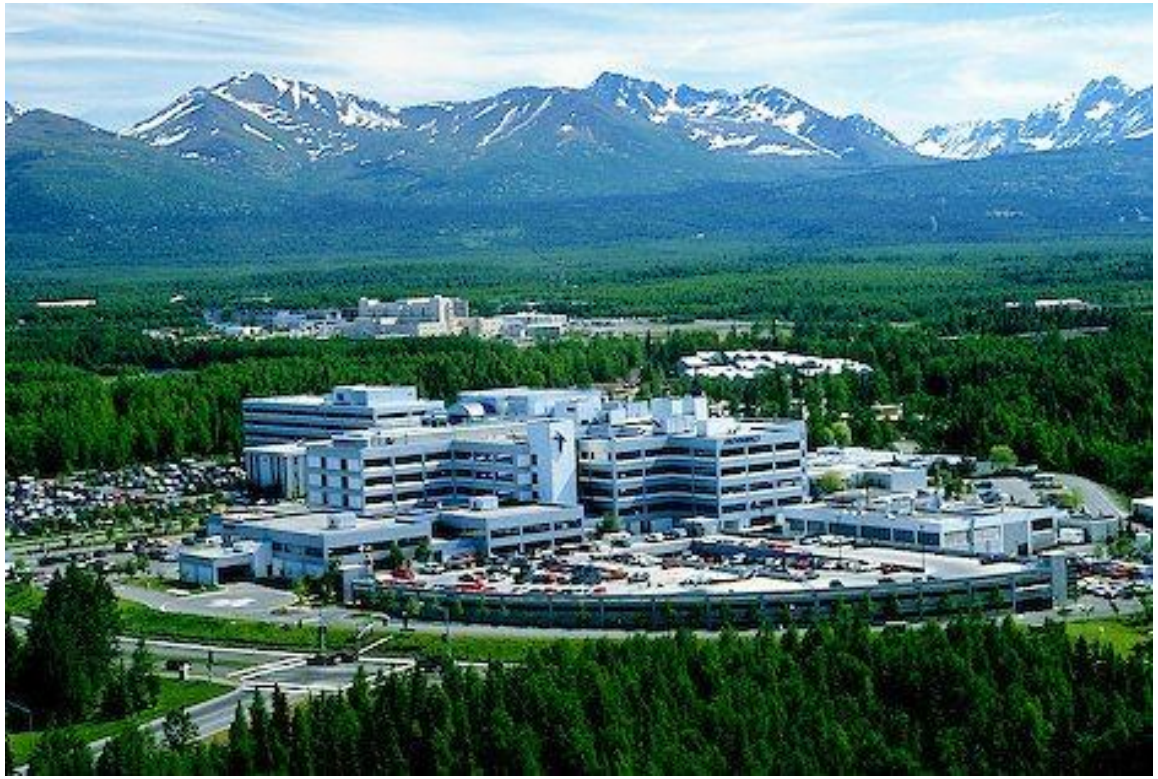


LEARNING OBJECTIVES

- By the end of this presentation the learner will be able to:
  - identify the components of a temporary epicardial pacemaker system.
  - discuss the steps for trouble-shooting common temporary pacemaker malfunctions.
  - describe how temporary epicardial atrial wires can be used to identify post-operative atrial dysrhythmias.

PRIMARY FUNCTION OF PACEMAKER

To deliver enough energy to consistently depolarize the heart (capture)

To correctly sense intrinsic cardiac activity

Increase HR to provide adequate CO

Coordinate AV conduction to increase CO

COMPONENTS OF PACING SYSTEMS

Pacemaker Generator

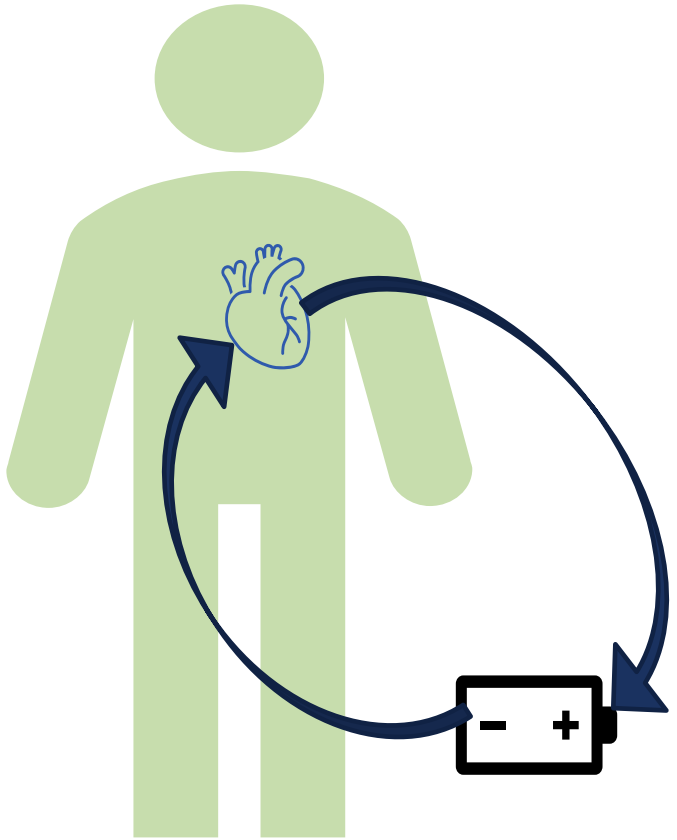
- Provides electrical stimulus
- Depolarization
- Contraction
- Ability to program impulse delivery

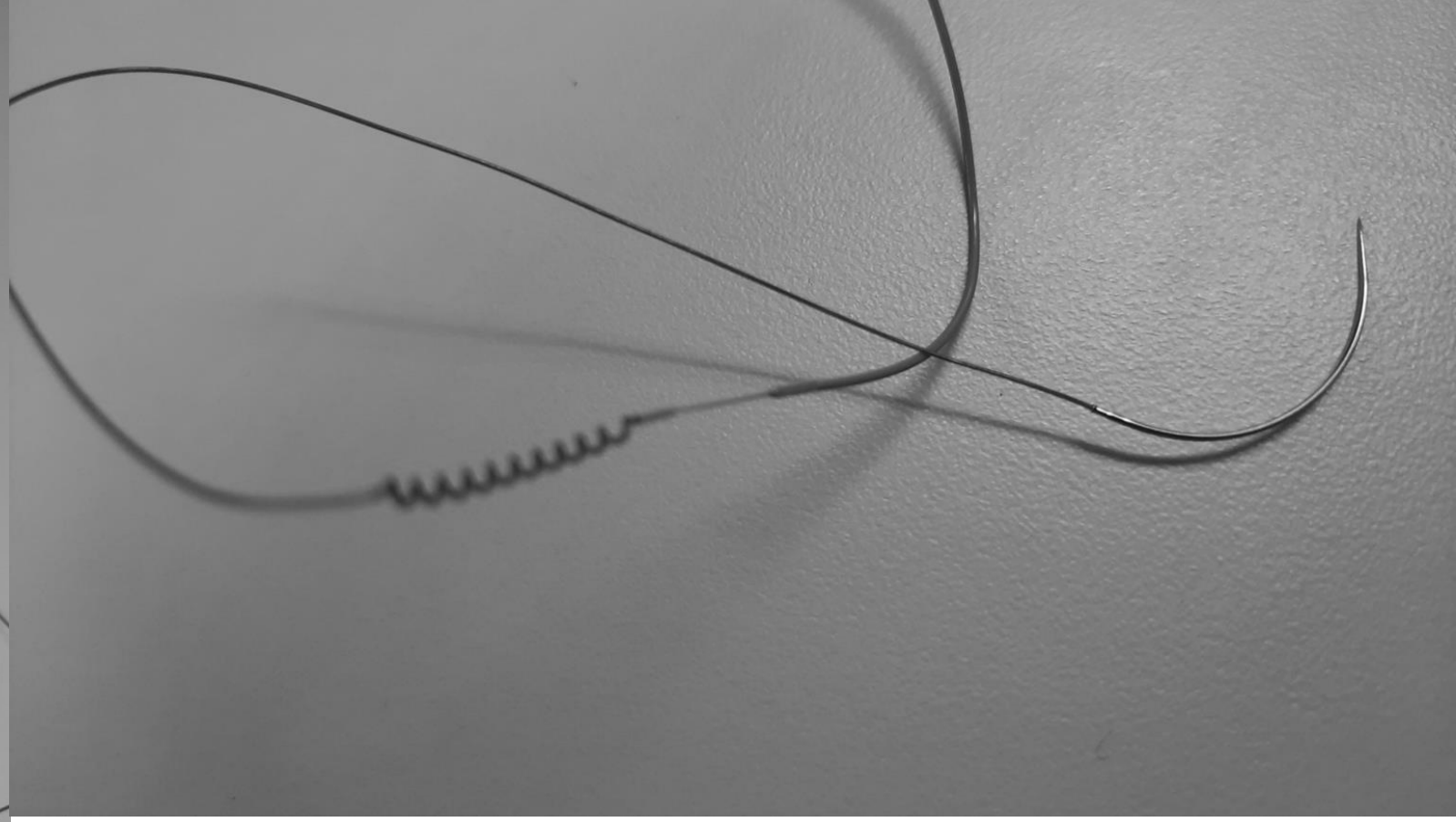
Lead or Electrode

- In *direct contact* with myocardial tissue
- Epicardium of atria or ventricles

LEAD SYSTEMS

- Circuit
- Electrical current flows
  - from **Negative** pole
    - Anode
  - to **Positive** pole
    - Cathode
    - Ground



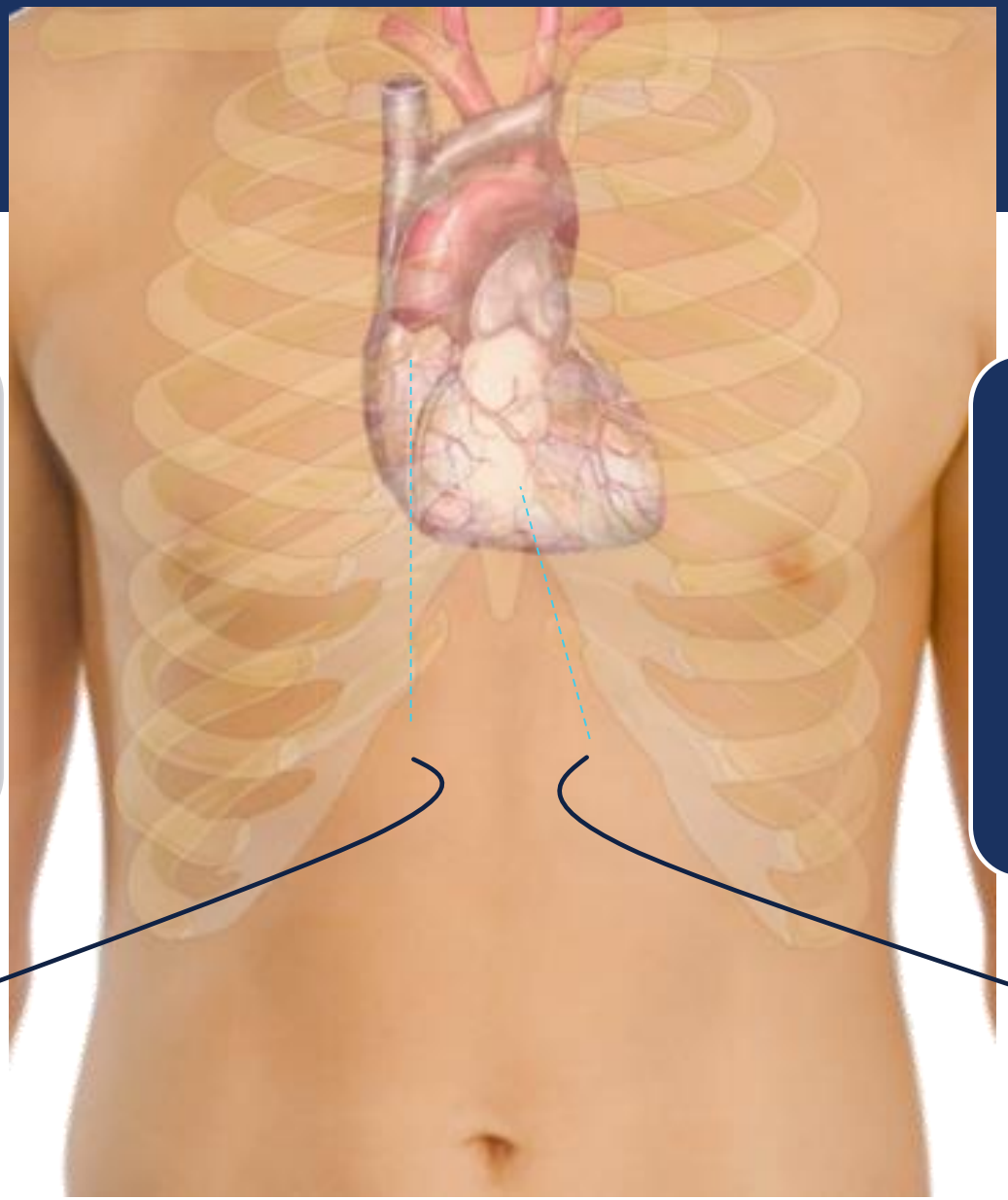


EPICARDIAL PACEMAKER LEADS

PACEMAKER LEADS

Right side of sternum

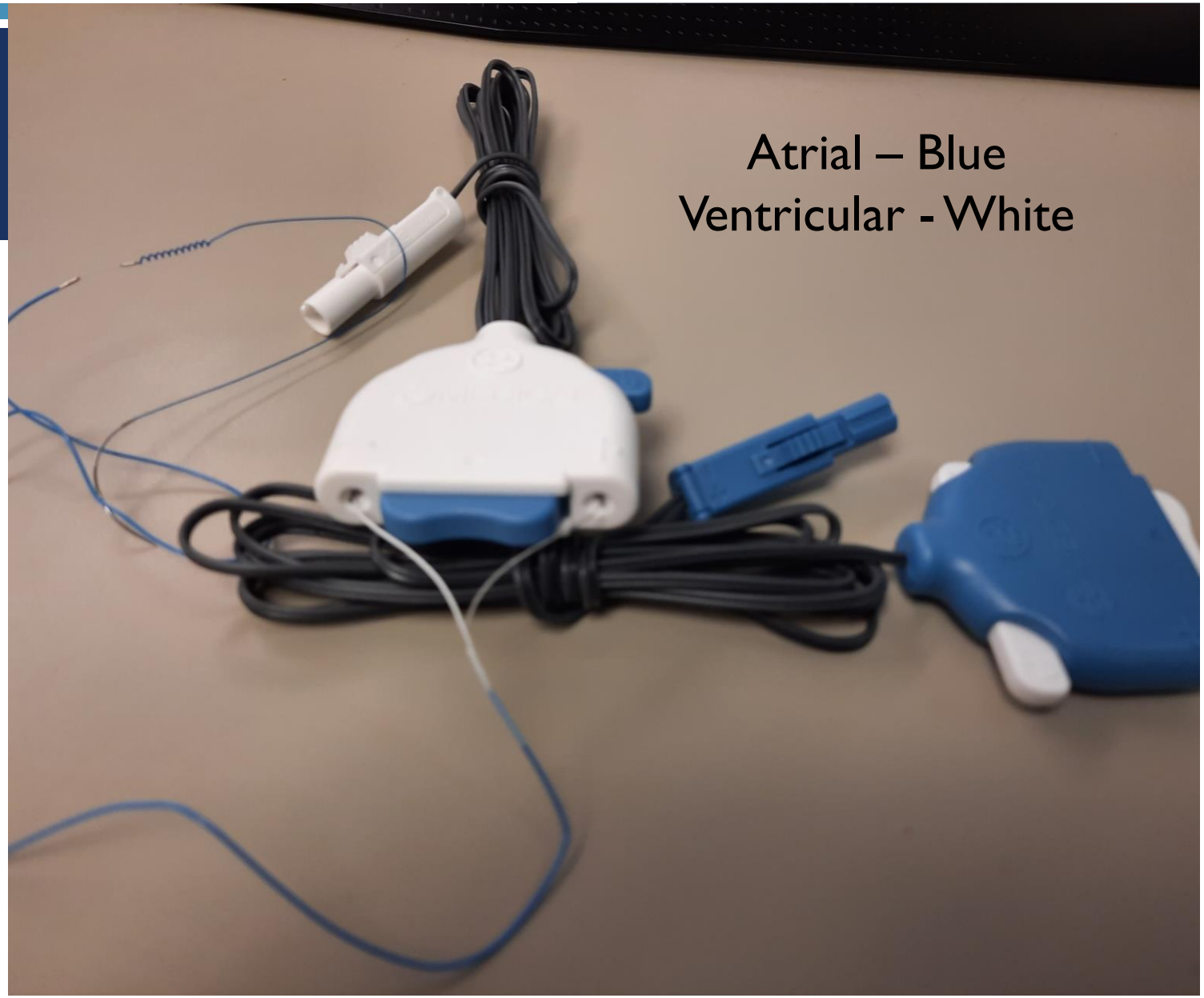
- Atrial wires



Left side of sternum

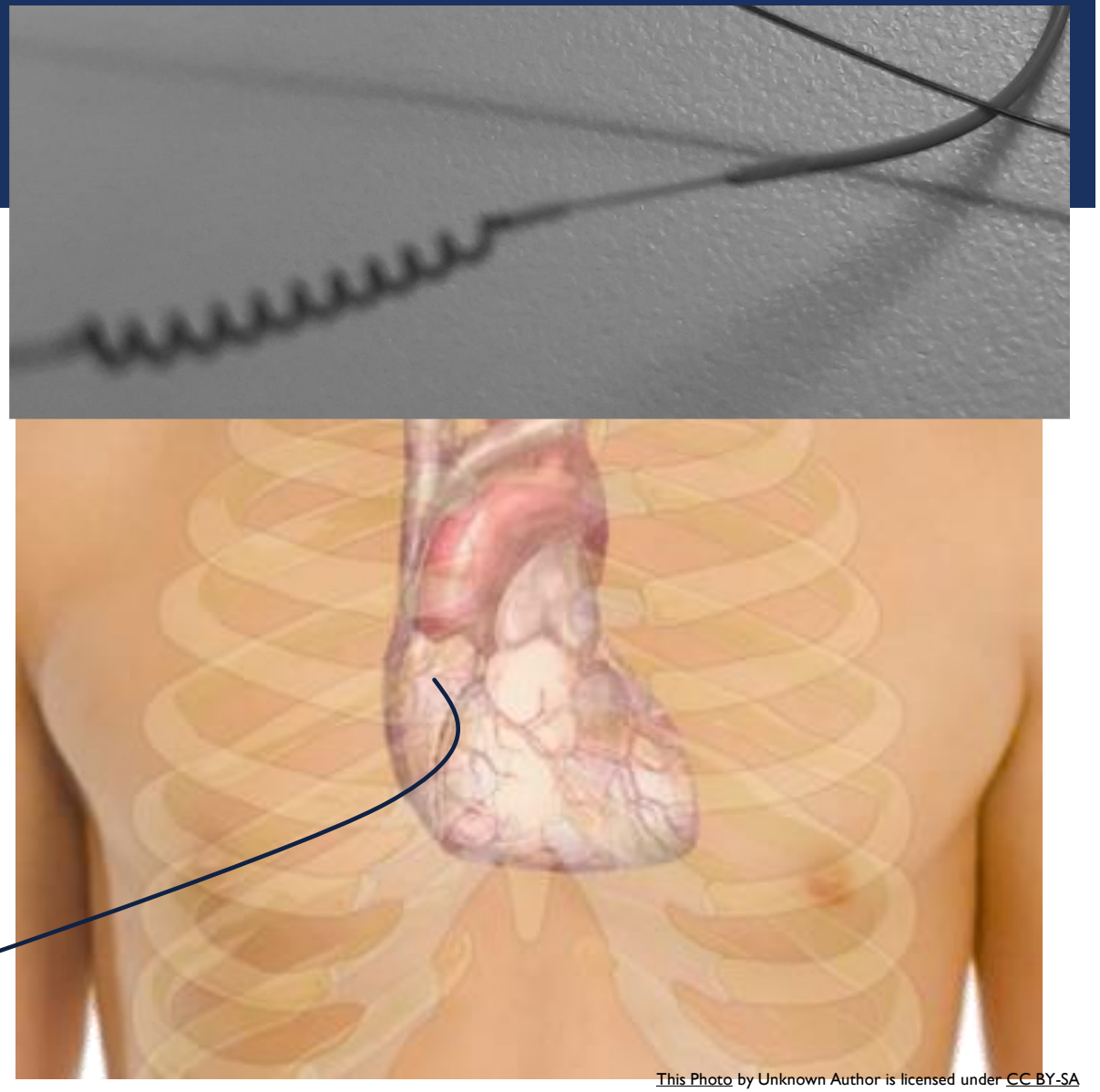
- Ventricular wires

CABLES



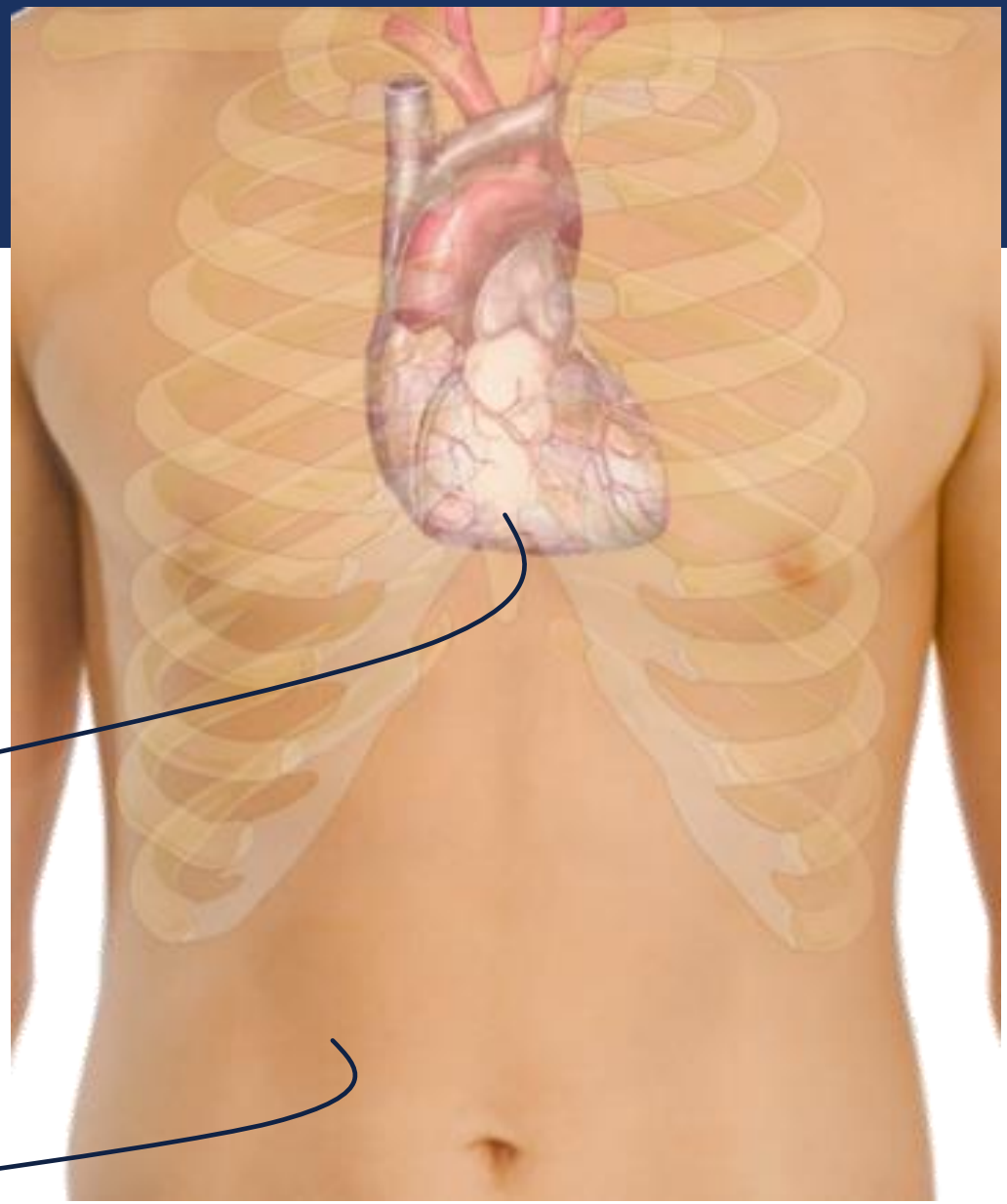
BIPOLAR LEADS

- Both electrodes in *same chamber*
- Small sensing current
- Small pacing spikes
- Either lead can serve as the negative pole
  - Can change polarity



UNIPOLAR LEADS

- Only one electrode *in* chamber
- Second pole in subcutaneous tissue
  - Ground wire
- Large sensing current
- Large pacing spikes
- Must connect neg lead to neg pole of generator
  - Cannot switch polarity
  - Cannot pace skin lead!



PACEMAKER CODES

Chamber Paced	Chamber Sensed	Response to Sensing
O = none	O = none	O = none
A = atrium	A = atrium	T = triggered
V = ventricle	V = ventricle	I = inhibited
D = dual (A + V)	D = dual (A + V)	D = dual (T + I)

SINGLE CHAMBER PACING MODES

AAI

VVI

DUAL CHAMBER PACING MODES

A and V pacing

A pacing and V sensing

A sensing and V pacing

A sensing and V sensing

PACEMAKER GENERATOR

Emergency = DOO

On/Off

Rate Dial

A Output (mA)

Battery Indicator

V Output (mA)

Lock/Unlock

ENTER Key

Up/Down Arrow Keys

Menu Dial

Pause Key

GENERATOR SETTINGS

Setting	Default	Range
Rate	80 bpm	30 - 200
Atrial Output	10 mA	0 - 20
Ventricular Output	10 mA	0 - 25
AV Interval	170 msec	20 - 300
Atrial Sensitivity	0.5 mV	0.4 – 10 mV
Ventricular Sensitivity	2.0 mV	0.8 – 20 mV

SELECTING A PACING MODE

1. Navigate to the Mode Selection menu.

2. Press the Up or Down Arrow keys to highlight a pacing mode.

3. Press the Enter key to select the pacing mode.

PACING RATE

- Optimal rate 80-100bpm
- Remember: CO = SV x HR
- Pacing > 10bpm above intrinsic rate can reduce the incidence of AF (when combined with antidysrhythmics)

Sets rate

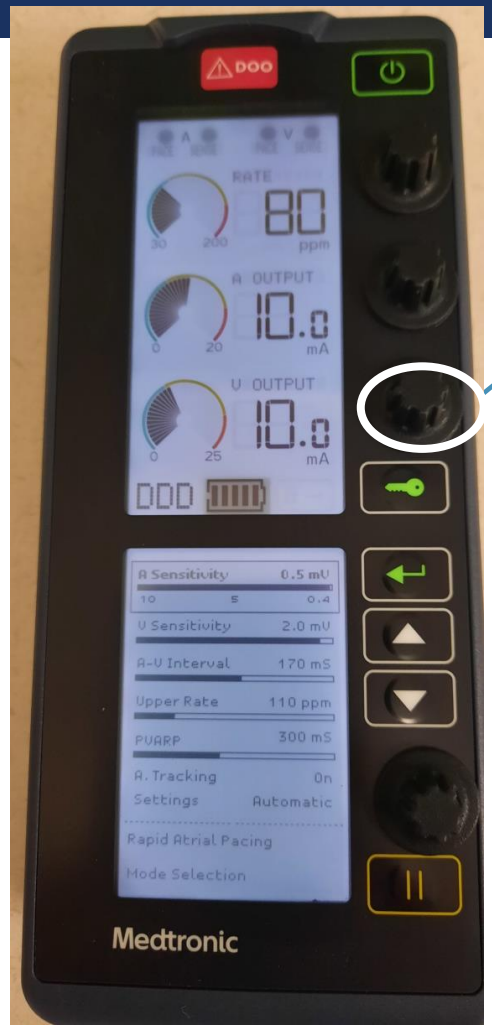
White MC, Caron MF, Kalus JS, et al. AFISTII. Circulation 2003;108:II-200-II-206.

ATRIAL MILLIAMPS

- Amount of electricity sent to the atrium
- Measured in mA

VENTRICULAR MILLIAMPS

- Amount of electricity sent to ventricles
- No dangerously high level
- Use for A-V conduction block



Sets mA output delivered via ventricular wires

A-V INTERVAL

Sets timing delay between atrial and ventricular impulses

Normal AV delay
120-170ms

Rate dependent

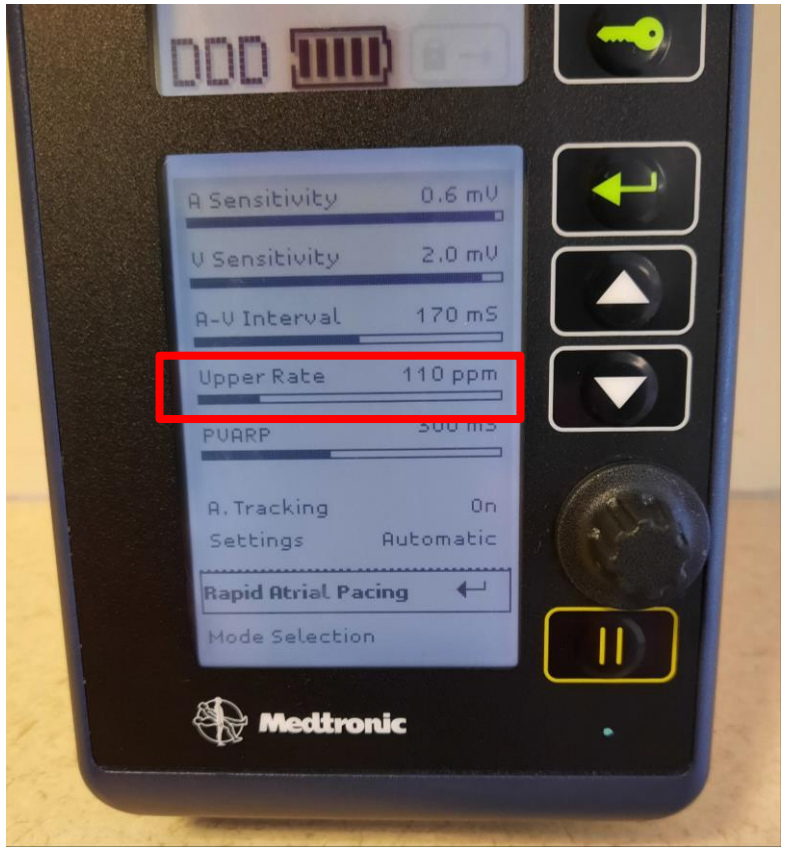
1st degree heart block >200ms

Preferably use native A-V conduction vs V pacing

Increase AV interval to promote sensing instead of V pacing (QRS narrows)

UPPER RATE LIMIT

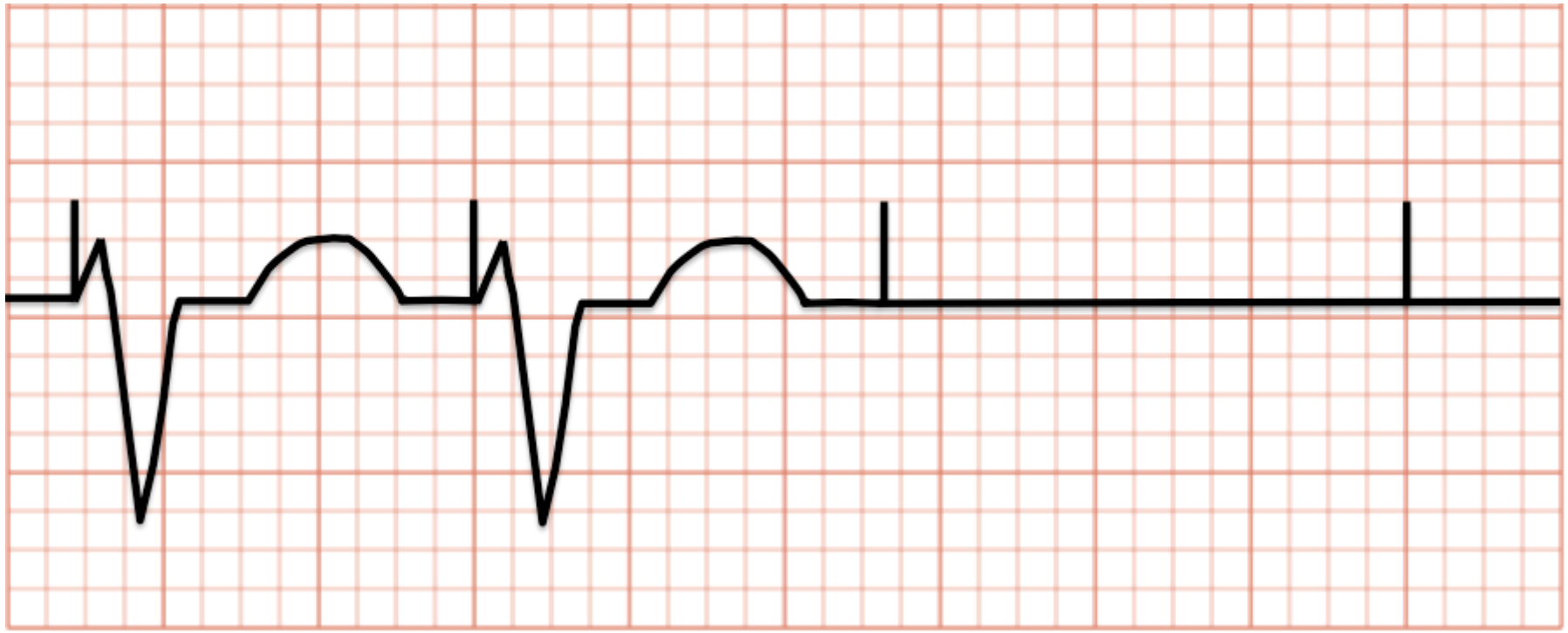
- Max atrial rate pacer will provide 1:1 ventricular pacing
- Prevents pacer from responding to rapid atrial rhythm
- Default = 110
- Only for DDD



RHYTHM ANALYSIS

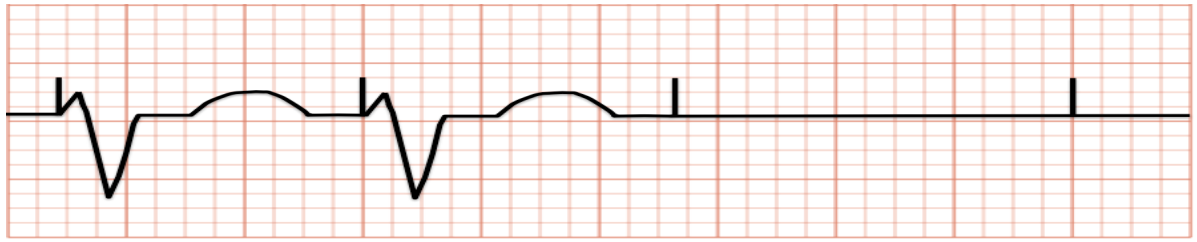
- Is there appropriate stimulation?
- P wave after every atrial spike
- QRS complex after every ventricular spike
- Do pacer spikes occur at the set rate
- Appropriate sensing

FAILURE TO CAPTURE



Electrical pacemaker stimuli does not result in depolarization

FAILURE TO CAPTURE



Possible Causes	Corrective Actions
Threshold rise	Check threshold & ↑ mA
Fractured or dislodged leads	Replace or reposition lead
Small QRS	Increase gain
Battery depletion	Replace battery
Faulty cable or connections	Check connections Change polarity

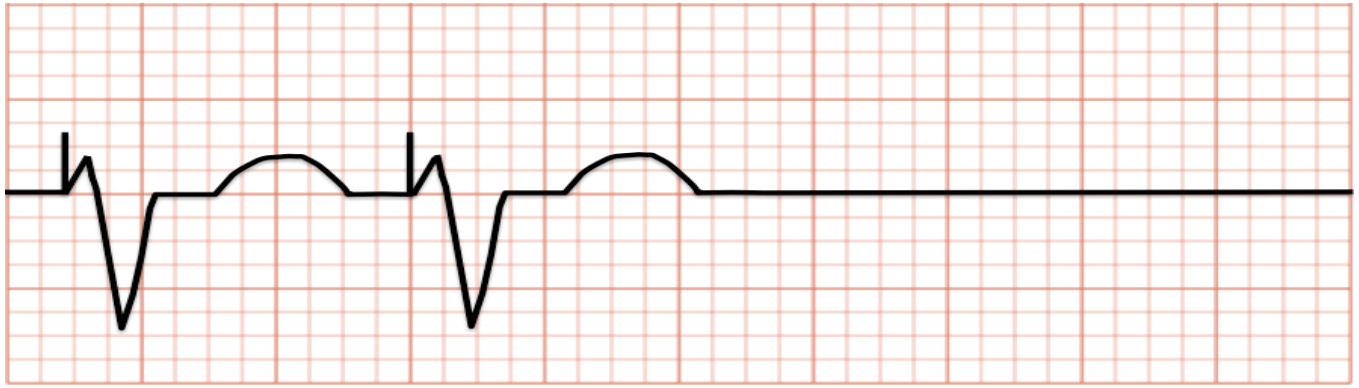
THE CAPTURE THRESHOLD IS NOT CONSTANT

	Capture	Sensing
Fluid status changes	X	X
Pericardial effusion	X	X
Electrolyte or metabolic abnormalities	X	
Medications	X	
Tissue inflammation, fibrosis, or necrosis	X	X
Generator battery failure	X	X
Development of endothelial sheaths	X	X
Disconnection, dislodgment, or fracture of leads	X	X

STIMULATION THRESHOLD

- Determines minimum amount of energy needed to reliably pace
- Paced rhythm must be present & patient stable
- Set rate 10 bpm above intrinsic rate
- Gradually *decrease output* until capture lost
- Gradually increase output until 1:1 capture returns → stimulation threshold
- Set mA 2 -3 times threshold value
- Restore rate to previous setting

FAILURE TO PACE



Possible Causes	Corrective Actions
Battery depletion	Change the battery
Pacemaker not turned on	Turn on pacemaker generator
Faulty cable connections	Secure all connections
Fracture/dislodged leads	Replace/reposition leads
Oversensing	Adjust sensitivity

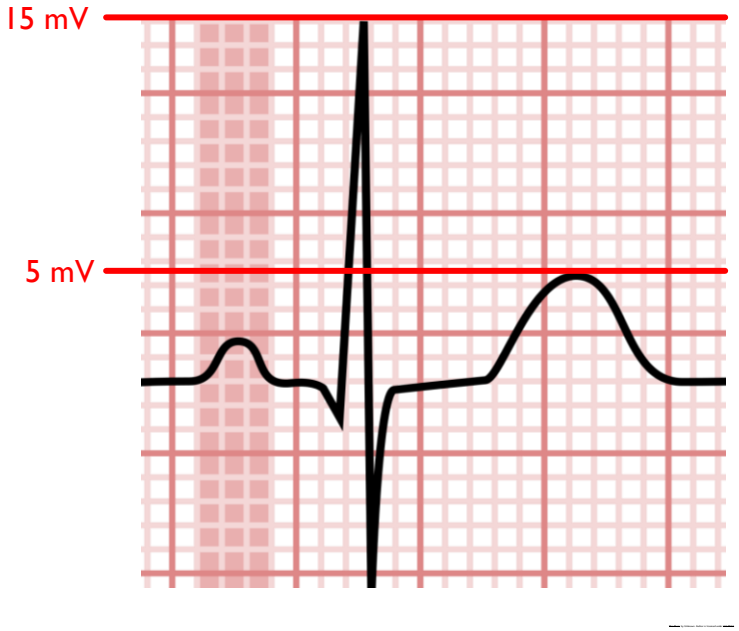
PACEMAKER DYSFUNCTION DIAPHRAGMATIC PACING

- Pacemaker stimulates diaphragm
- Hiccups, chest wall muscle twitching, or pulsating diaphragm, pain
- mA set too high
- Pacer wires dislodged from epicardium
- Treatment: ↓ mA, Reposition pt. on side

SENSITIVITY

- Ability of Pacer to sense intrinsic beat
- Amplitude of the ECG complex required for the pacemaker to recognize patient's intrinsic cardiac activity
  - mV of complex
- Failure to sense → DOO or VOO mode
- R on T may occur

SENSITIVITY

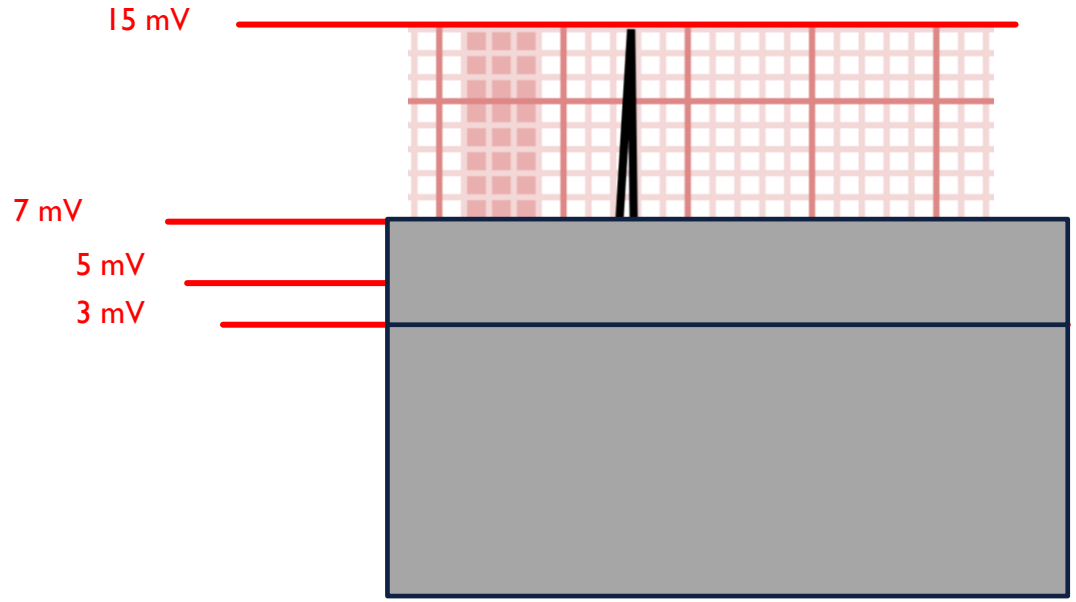


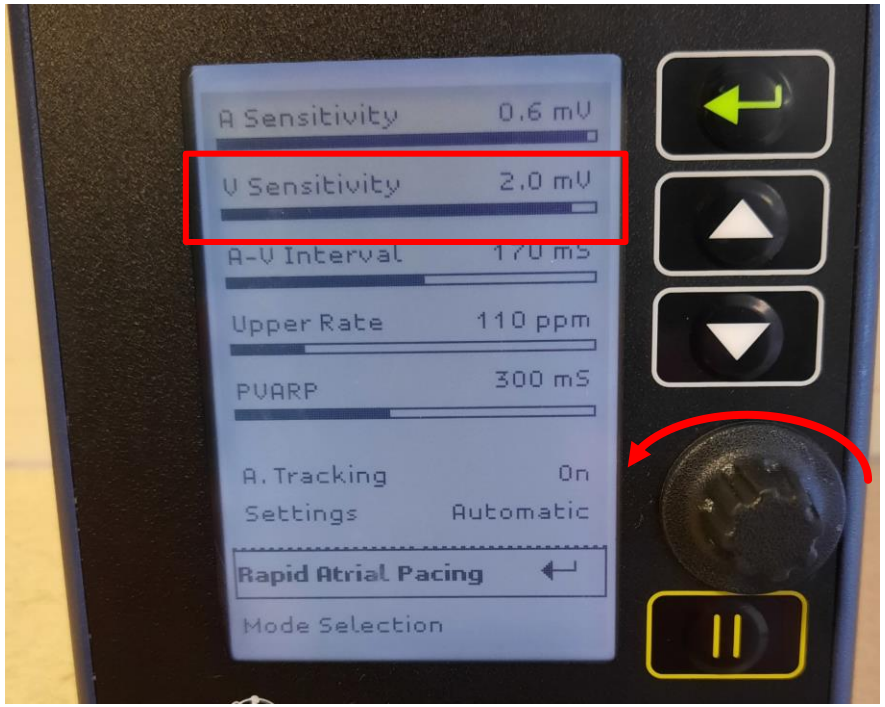
- Sets the **amplitude** (height) of complex pacemaker requires to detect an intrinsic beat
- Measured in millivolts (mV)

- **High Sensitivity = Low Number**
- **Low Sensitivity = High Number**

OVERSENSING
TURN SENSITIVITY DOWN

- Detect complexes inappropriately
- Does not pace when it should
- Turn knob counterclockwise
- Raise the mV number
- Cover up the complexes that you do not want sensed
- Higher mV → pacemaker less sensitive

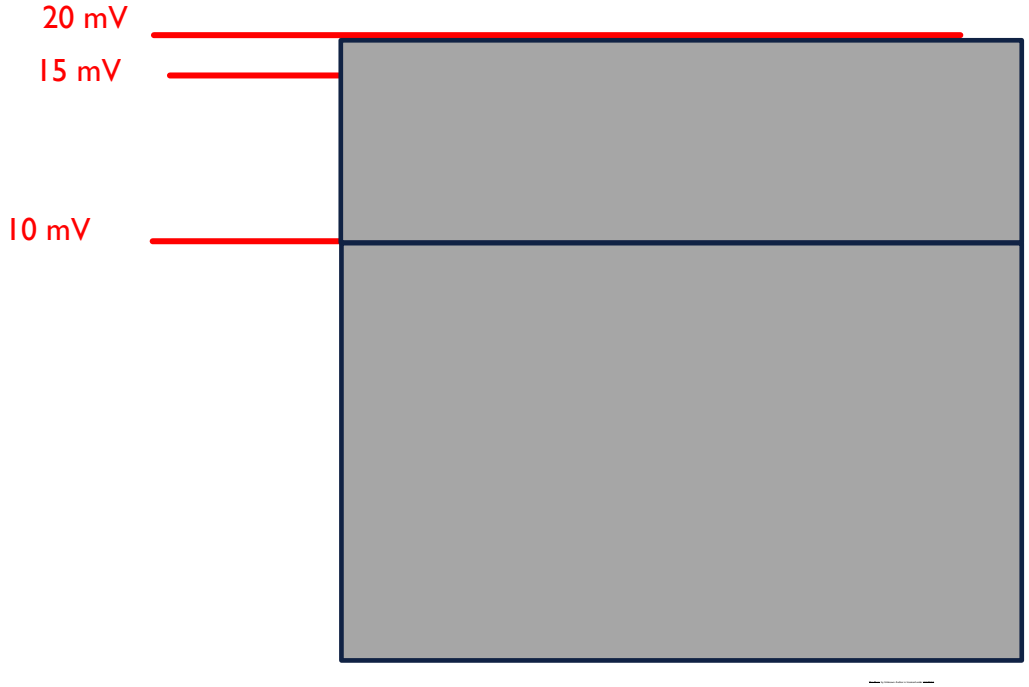


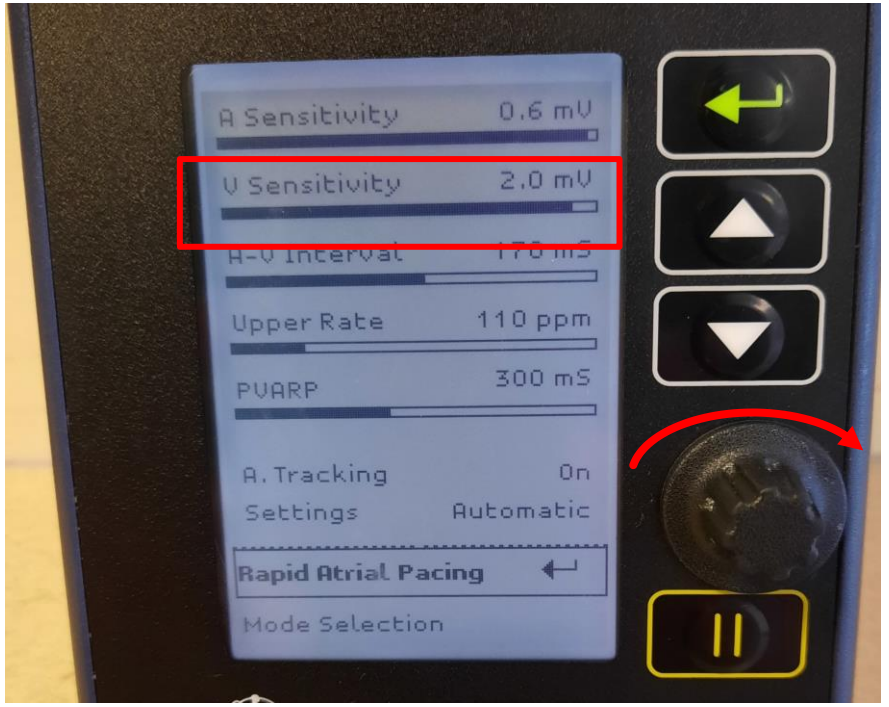


UNDERSENSING
TURN SENSITIVITY UP

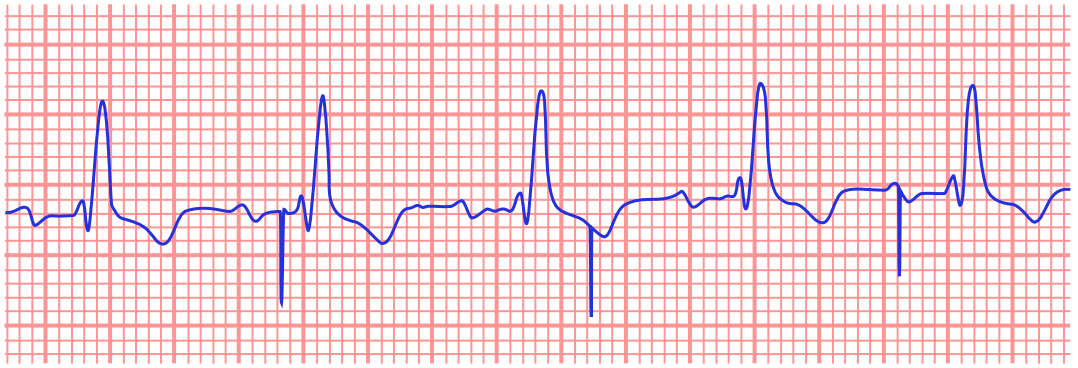
- Does not detect complexes
- Paces when it should not
- Turn knob clockwise
- Smaller number - lower the mV
- Recognizes electrical activity of smaller amplitude

Pacing Asynchronously



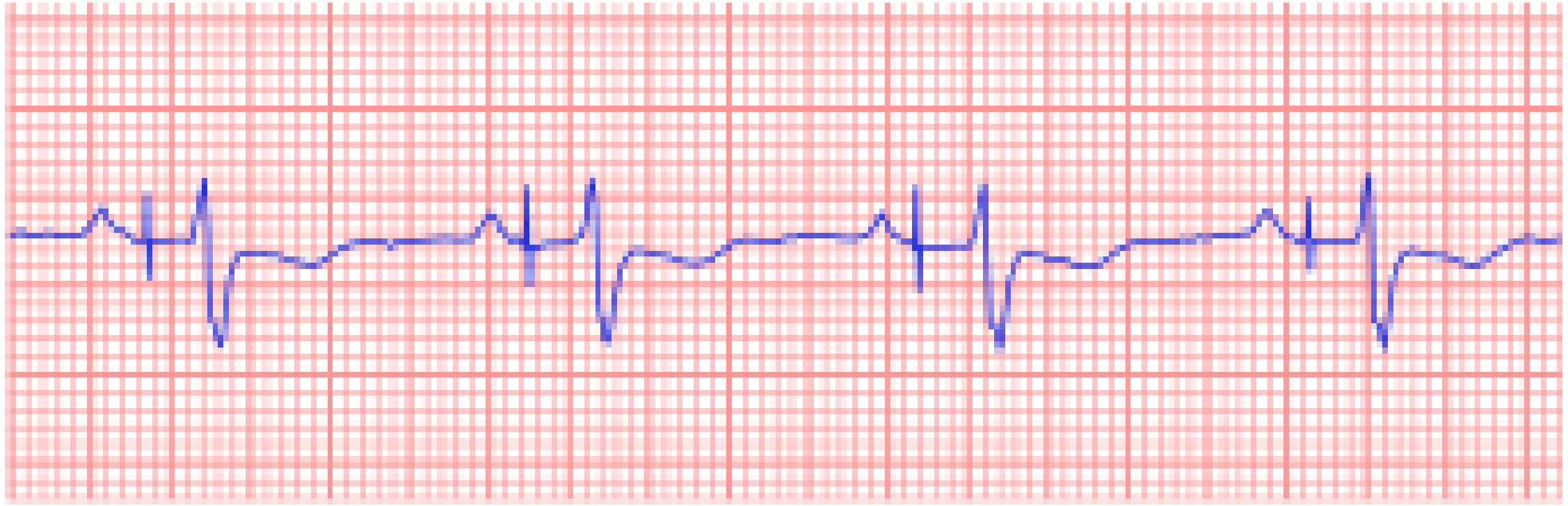


UNDERSENSING



Possible Causes	Corrective Actions
Decreased QRS size	Increase sensitivity
Fractured/dislodged lead	Replace/reposition lead
Battery depletion	Replace battery
Inappropriate sensitivity setting	Increase sensitivity - ↓ mV number

ATRIAL UNDERSENSING

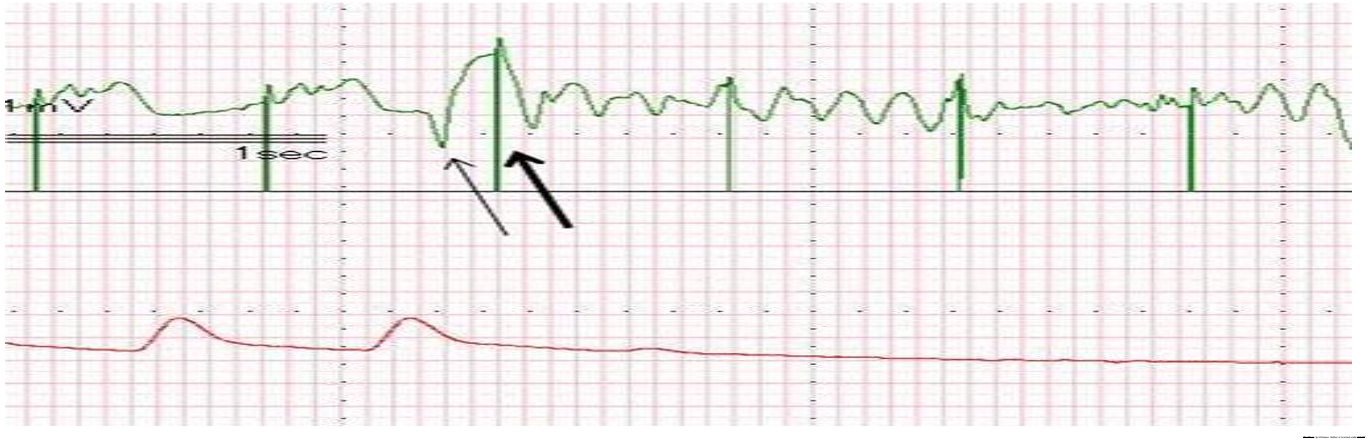


WHAT COULD GO WRONG?

PACEMAKER INDUCED R ON T PHENOMENON

Anesthesiology, *132*(2), 374

PACEMAKER INDUCED R ON T PHENOMENON

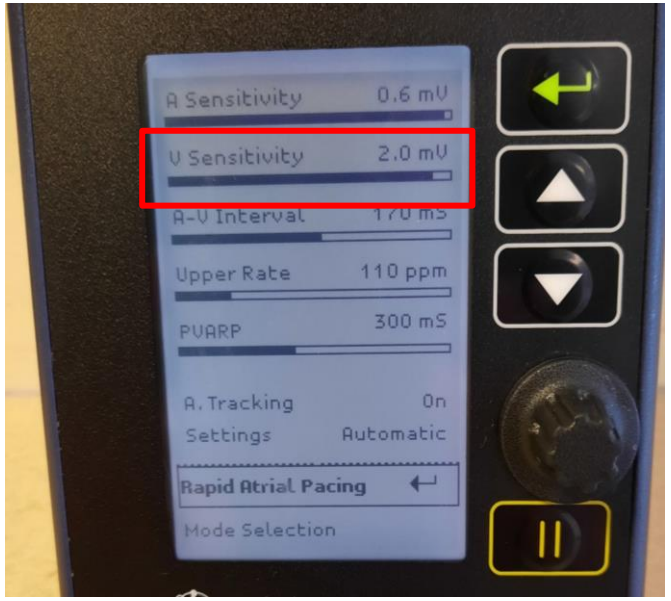


Possible Causes	Corrective Actions
Inappropriate sensitivity setting	Increase sensitivity - ↓ number
Loose connection Fractured lead	Check and secure connections

SENSING THRESHOLD

Patient must have an underlying rhythm and tolerate a brief period without pacing

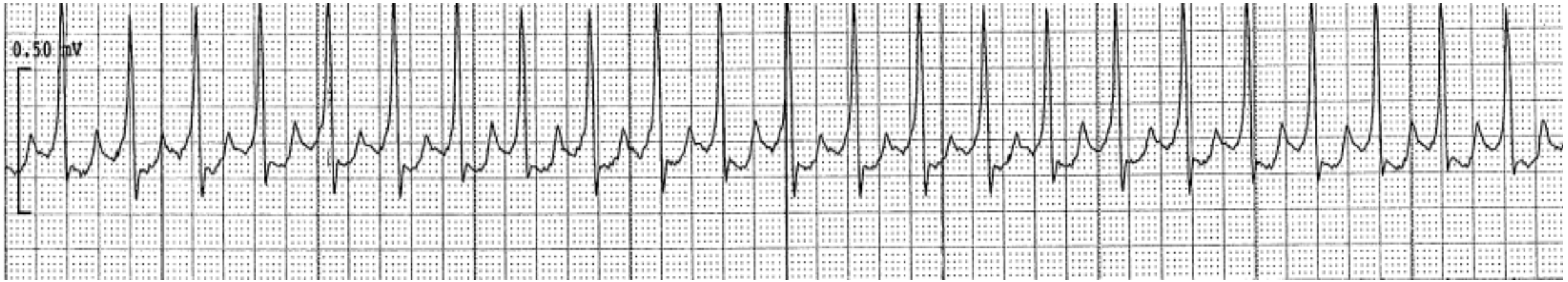
Set	RATE 10 bpm below intrinsic heart rate
Set	Set mA at 0.1 mA
Highlight	Highlight SENSITIVITY menu
Decrease	Decrease SENSITIVITY: Slowly turn dial counter-clockwise until pace indicator flashes continuously (asynch)
Increase	Increase SENSITIVITY: Slowly turn dial clockwise until sense indicator flashes again (when sensing resumes=sensing threshold)
Set	Set SENSITIVITY < half this value
Restore	Restore previous rate



OTHER USES OF ATRIAL PACING WIRES

- Identification of SVT rhythm
- Enhances visualization of "hidden" atrial activity
- Rapid atrial (overdrive) pacing

75 –YEAR OLD FEMALE 2 DAYS AFTER CARDIAC SURGERY HR 147, BP 110/70, ASYMPTOMATIC



What is this rhythm?

ATRIAL ELECTROGRAM

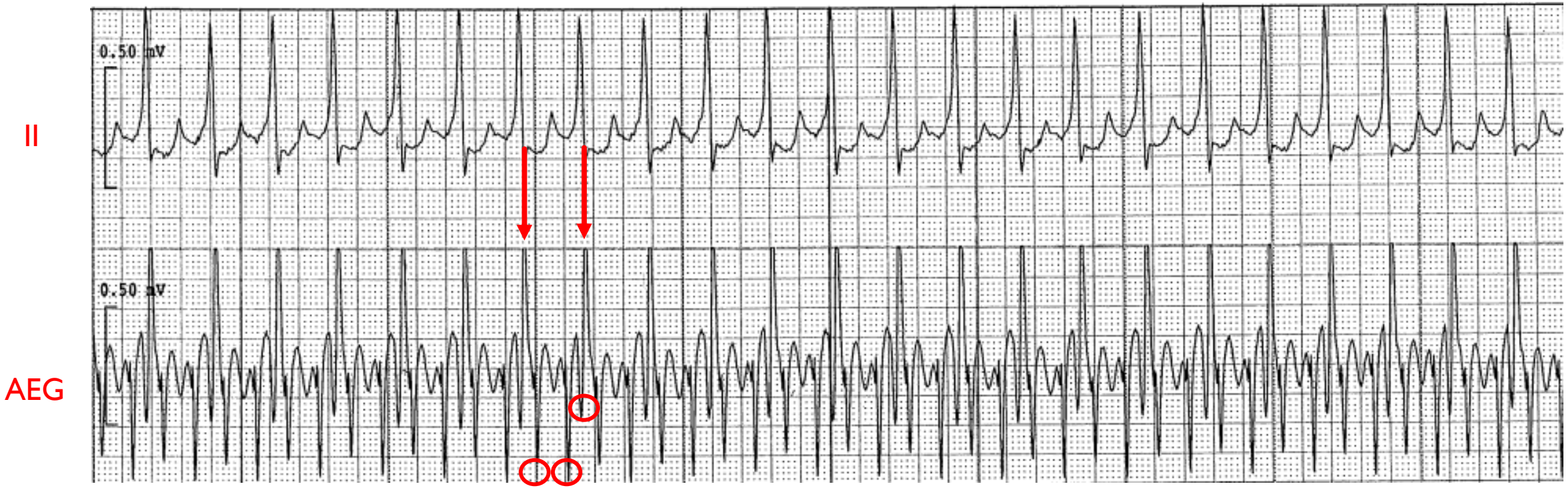
- Records electrical activity from atria
- Atrial pacing wires connected to ECG cables
- Enhanced tracing of atrial activity
- Allows comparison of atrial & ventricular events
- Narrow complex SVT
  - AF/FL vs. ST
- Wide complex tachycardia
  - VT versus SVT w/ aberrant conduction

AACN advanced critical care, *26*(3), 275–280

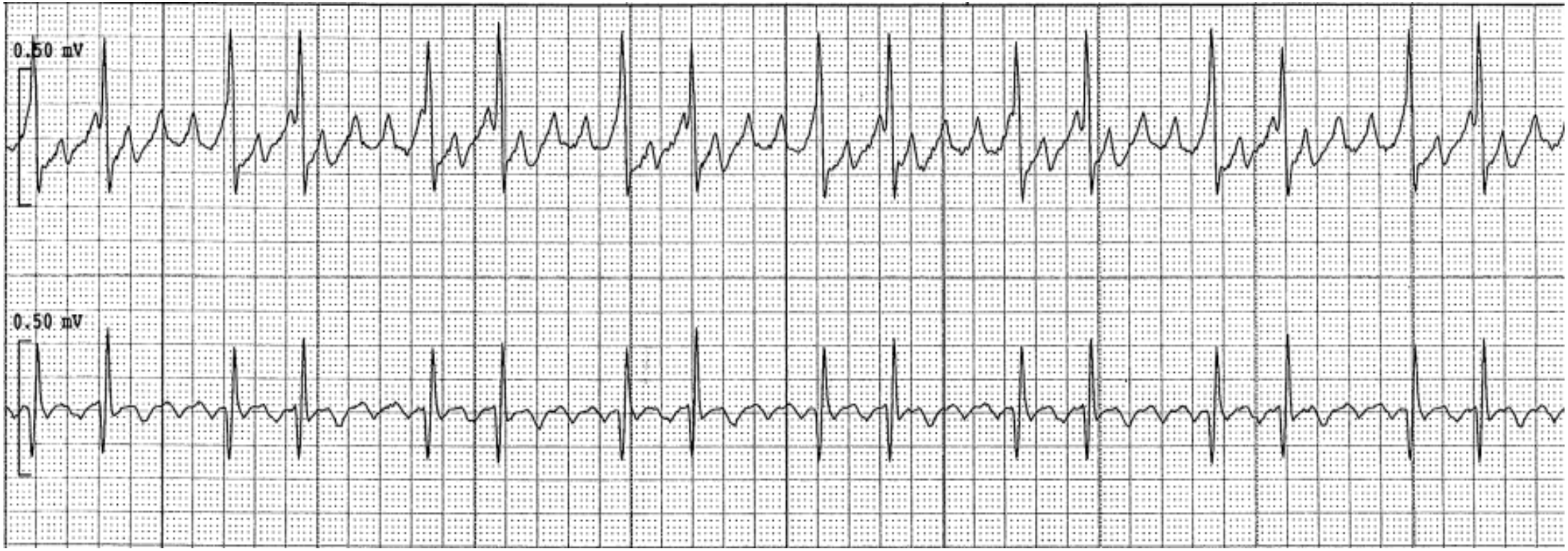
ATRIAL ELECTROGRAM

- Wear gloves
- Locate atrial wires to R side of chest
- Atrial wire to brown lead
  - Monitor V lead
- Run long strip of V_1 & another lead
- Evaluate for accentuated P waves

ATRIAL ELECTROGRAM (AEG)

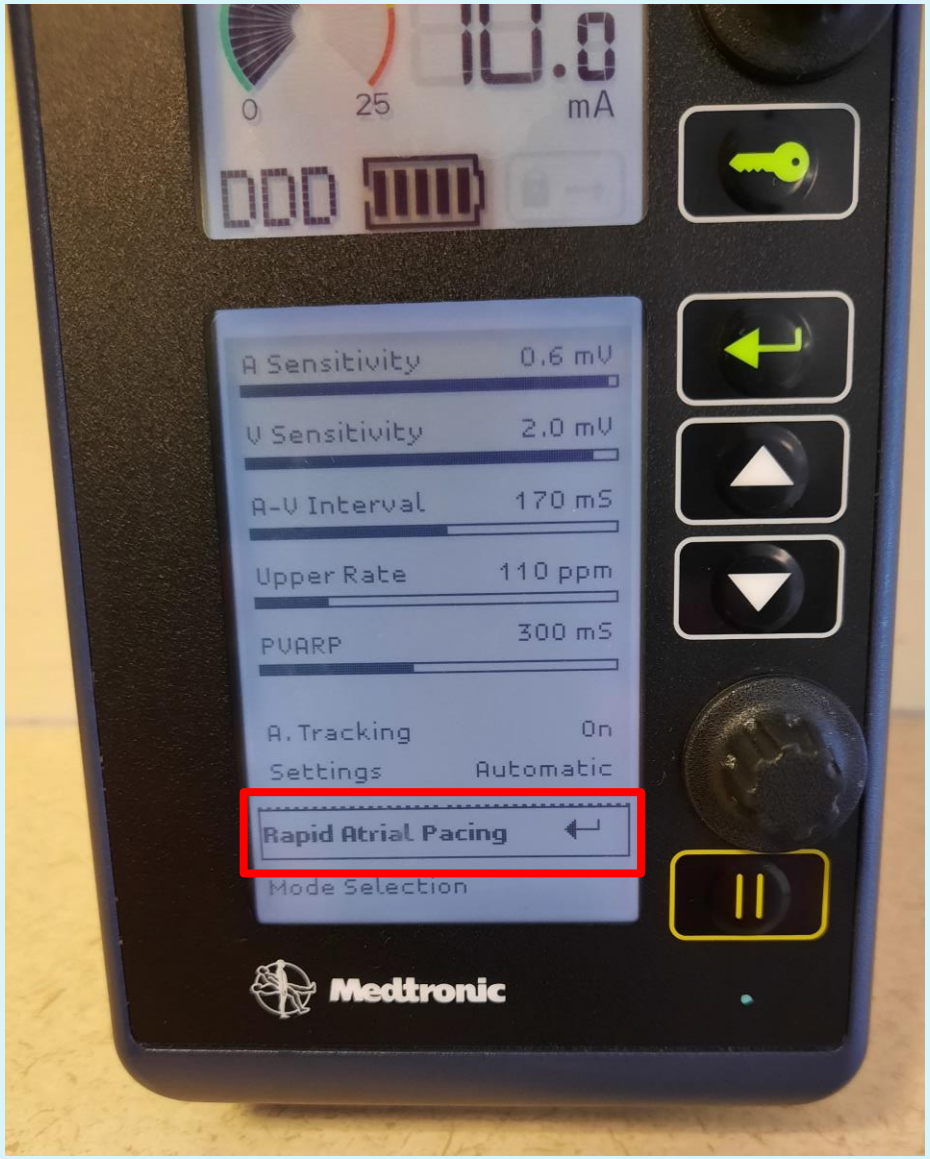


SAME PATIENT AFTER DILTIAZEM GIVEN



RAPID ATRIAL PACING

- Atrial burst pacing
- AOO
- Delivery of rapid electrical stimuli to atrium
- To interrupt rapid atrial tachydysrhythmias
- RAP rate must be > intrinsic rate
- Range 100 to 800



RAPID ATRIAL PACING

Verify atrial leads connected to atrial cable

Press the Up or Down Arrow key to highlight **Rapid Atrial Pacing**

Press the Enter to open the RAP screen.

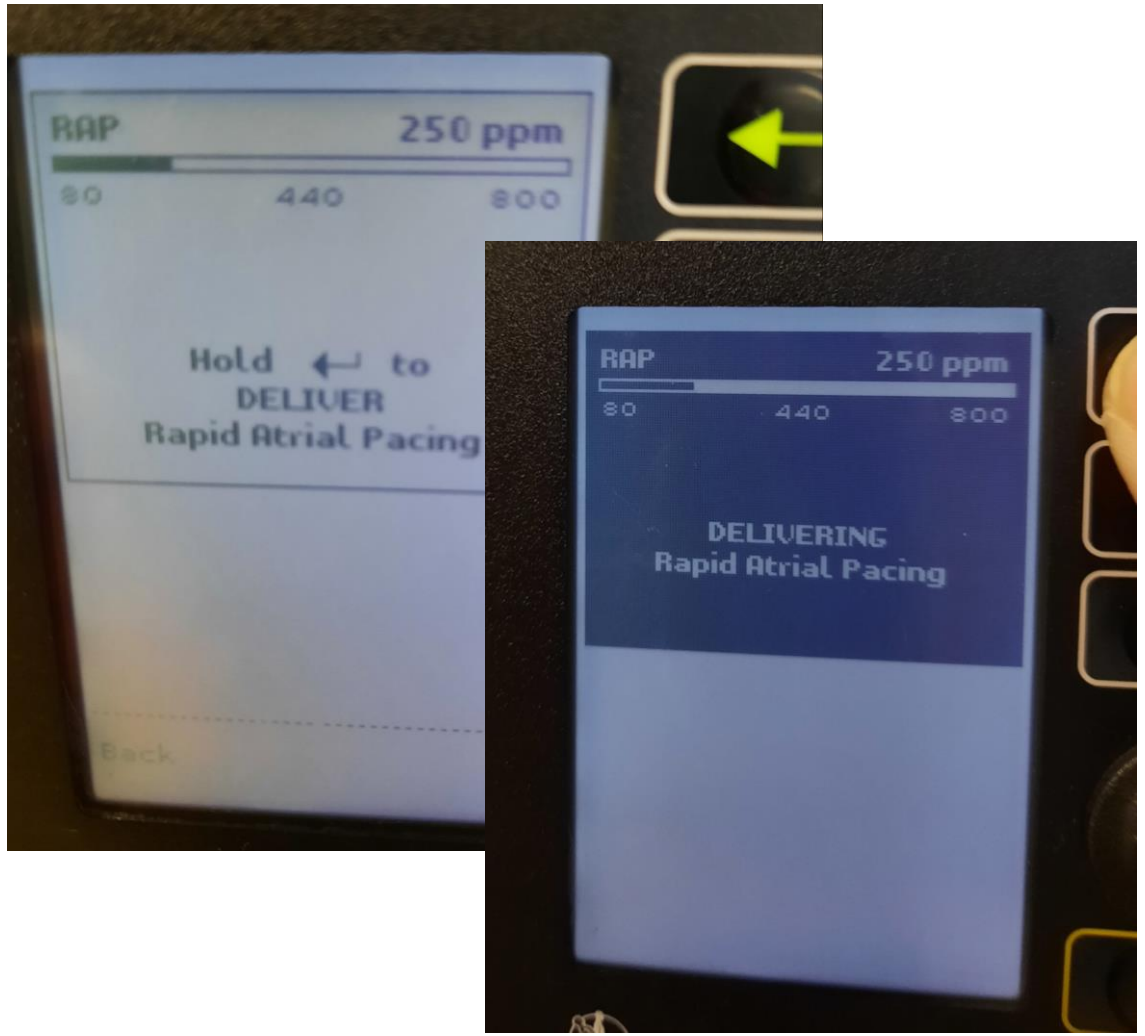
Adjust RAP rate as needed;

Range 80 ppm to 800 ppm

Press and hold the Enter key to deliver RAP burst

AOO pacing begins

To stop pacing - *release* ENTER or stops after 1 min



NURSING RESPONSIBILITIES

Ensure
- Appropriate pacing mode

Determine
- Underlying rhythm if stable

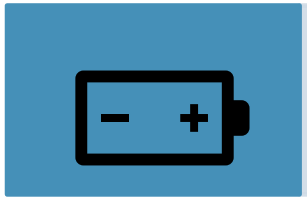
Assess
- Appropriate capture
- Appropriate sensing

Troubleshoot
- Troubleshoot as needed

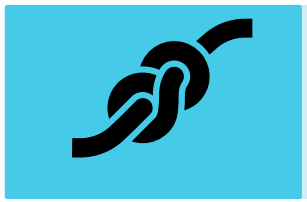
Obtain
- Obtain ECG tracing
  - Paced rhythm
  - Underlying rhythm

Prevent
- Prevent microshock

NURSING CARE



Check battery

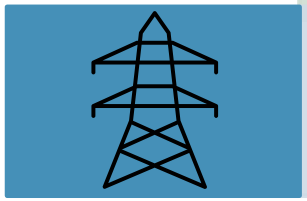


Check connections

Check site of wire insertion

Change dressing every 24 hours

Secure wires & cables to prevent dislodgement



Where is back-up generator?

Epicardial Pacemaker Wire Dressings

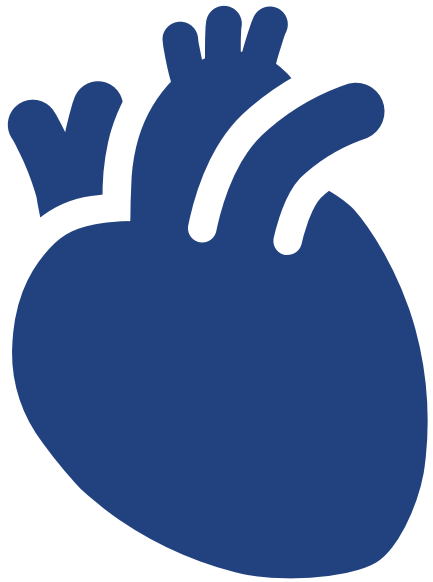
1. Wear gloves
2. Cut off the tip of fingers from another glove
3. Place the pacer wires inside the cut fingertips
    - Atrial wires in one finger
    - Ventricular wires in the other
    - Insulates wires - protect from microshock
4. Place a gauze 4X4 on the patient's chest
5. Coil pacemaker wires and glove finger on top
6. Cover the pacemaker wires with another 4X4
7. Tape it in place.
    - Do not put tape directly on wires!
8. Label wires to identify atrial and ventricular

EPICARDIAL PACING WIRE REMOVAL

- Sutures removed
- Wires removed with *gentle* pulling action
- Monitor for ectopy
- Bedrest for 30 minutes after removal
- Observe for cardiac tamponade

Annals of Cardiac Anaesthesia. 2017; *20*(4): 459–461
Journal of Cardiac Surgery. 2020; *35*(6): 1247–1252

SIGNS OF CARDIAC TAMPONADE



- Tachycardia
- Hypotension
- Tachypnea
- Chest pain
- Sense of foreboding
- Notify Surgeon

CONCLUSIONS

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REFERENCES

- Abd Elaziz, M. E., & Allama, A. M. (2018). Temporary Epicardial Pacing After Valve Replacement: Incidence And Predictors. *The heart surgery forum*, *21*(1), E049–E053. https://doi.org/10.1532/hsf.1853
- Bougioukas, I., Jebran, A. F., Grossmann, M., Friedrich, M., Tirilomis, T., Schoendube, F. A., & Danner, B. C. (2017). Is there a correlation between late re-exploration after cardiac surgery and removal of epicardial pacemaker wires?. *Journal of cardiothoracic surgery*, *12*(1), 3. https://doi.org/10.1186/s13019-017-0569-5
- Chen, M. Y., & Mundangepfupfu, T. (2020). Sustained Ventricular Tachycardia Secondary to R-on-T Phenomenon Caused by Temporary Ventricular Epicardial Pacemaker Undersensing after Cardiac Surgery. *Anesthesiology*, *132*(2), 374. https://doi.org/10.1097/ALN.0000000000002990
- Cote, C. L., Baghaffar, A., Tremblay, P., & Herman, C. (2020). Incidence of tamponade following temporary epicardial pacing wire removal. *Journal of cardiac surgery*, *35*(6), 1247–1252. https://doi.org/10.1111/jocs.14564
- Cote, C. L., Baghaffar, A., Tremblay, P., & Herman, C. R. (2020). Prediction of temporary epicardial pacing wire use in cardiac surgery. *Journal of cardiac surgery*, *35*(8), 1933–1940. https://doi.org/10.1111/jocs.14870
- Elmistekawy E. (2019). Safety of temporary pacemaker wires. *Asian cardiovascular & thoracic annals*, *27*(5), 341–346. https://doi.org/10.1177/0218492319833276
- Ley, S. J., & Koulakis, D. (2015). Temporary Pacing After Cardiac Surgery. *AACN advanced critical care*, *26*(3), 275–280. https://doi.org/10.1097/NCI.0000000000000091
- Reade M. C. (2007). Temporary epicardial pacing after cardiac surgery: a practical review: part 1: general considerations in the management of epicardial pacing. *Anaesthesia*, *62*(3), 264–271. https://doi.org/10.1111/j.1365-2044.2007.04950.x
- Reade M. C. (2007). Temporary epicardial pacing after cardiac surgery: a practical review. Part 2: Selection of epicardial pacing modes and troubleshooting. *Anaesthesia*, *62*(4), 364–373. https://doi.org/10.1111/j.1365-2044.2007.04951.x
- Suthar, R., Salaria, O. N., De La Cuesta, C., & Viswanath, O. (2017). Two episodes of cardiac tamponade in the same patient from removing pacing wires and a pericardial drain: A case report. *Annals of cardiac anaesthesia*, *20*(4), 459–461. https://doi.org/10.4103/aca.ACA_67_17