# Pacemaker Follow up and Troubleshooting

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# Outline

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# Introduction

- Management of pacemaker patients does not end with implantation!
- Follow up is essential to
  - Identify and manage malfunction
  - Improve quality of life by optimal programming
  - Prolong battery life by optimising output
  - Anticipate battery depletion and plan for replacement

# Follow up Schedule

- 6 weeks post implant
- 6 months
- Yearly thereafter
- More frequent followups with approaching ERI

# Clinical Evaluation

# History

- Indication, implanted device
- Time of implant, procedure notes
- Any symptoms of potential device malfunction

# Keep your ears open

- Patient with VVI pacemaker for CHB complains of giddiness while bathing
- I count my pulse everyday, instead of 60, it was 65 today

# Physical examination

- JVP
- Pocket
- Chest wall / diaphragmatic stimulation

# ECG

- Pacing and sensing
- Change in QRS morphology
- Battery status
- Magnet application

# Bidirectional telemetry

# Telemetry

- Telemetry is ability to transmit information from one device to another
- Interrogate programmed data
- Measured data
- Program the device parameters

# Assessing battery status

# Battery voltage

- Lithium Iodine Cell
- BOL 2.8 V
- Manufacturer recommended values for closer follow up / replacement

# Battery Impedance

- Inversely related to voltage
- Lithium Iodide accumulation forms resistive barrier
- More than 1000 ohms indicates reduced battery life

# Other markers of battery life

- Expected longevity
- ERI indicator

# Assessing lead status

# Lead Impedance

- Broad range of normal values for any lead model
- For a specific lead, impedance should be within a narrow range
- Further evaluation required for marked change in impedance ($>$ 200 Ohms)

# Fall in impedance

- Insulation break
- Provides alternate pathway for current flow to generator (unipolar)
- Unipolarization of the lead in bipolar lead with outer insulation break

# Bipolar lead with inner insulation break

- Loss of capture
- May cause oversensing
- Conversion to unipolar results in higher impedance

# Increase in impedance

- Conductor fracture
- Connector problem
- May be intermittent

# Assessing pacing system function

# Pacing threshold

- Decremental method
- Amplitude decrement

# Signal amplitude

- Needs intrinsic rhythm
- Measured by device
- May be printed and measured

# Maneuvers to unmask malfunction

- Carotid sinus massage to slow sinus rate
- Positional changes to assess sensing
- Manipulation of device - lead fracture / loose connection
- Movement of ipsilateral arm / isometric exercise

# Pacing System Malfunction

# Failure of output (no spike)

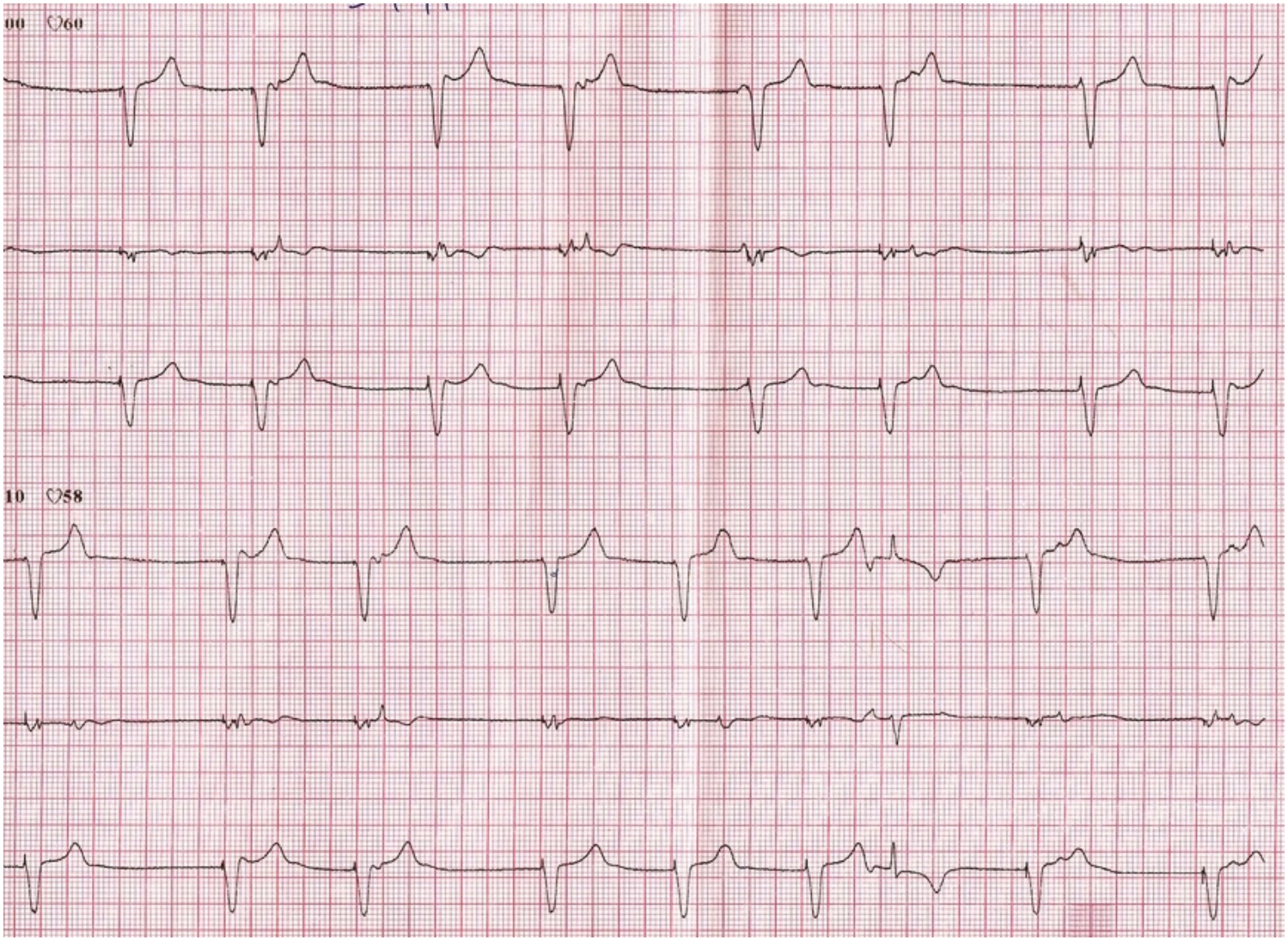
# Pseudo-malfunction

- Programmed rate lower than sinus rate
- Hysteresis

# Hysteresis

# Oversensing

- Physiological signals
- Make-break signals
- Crosstalk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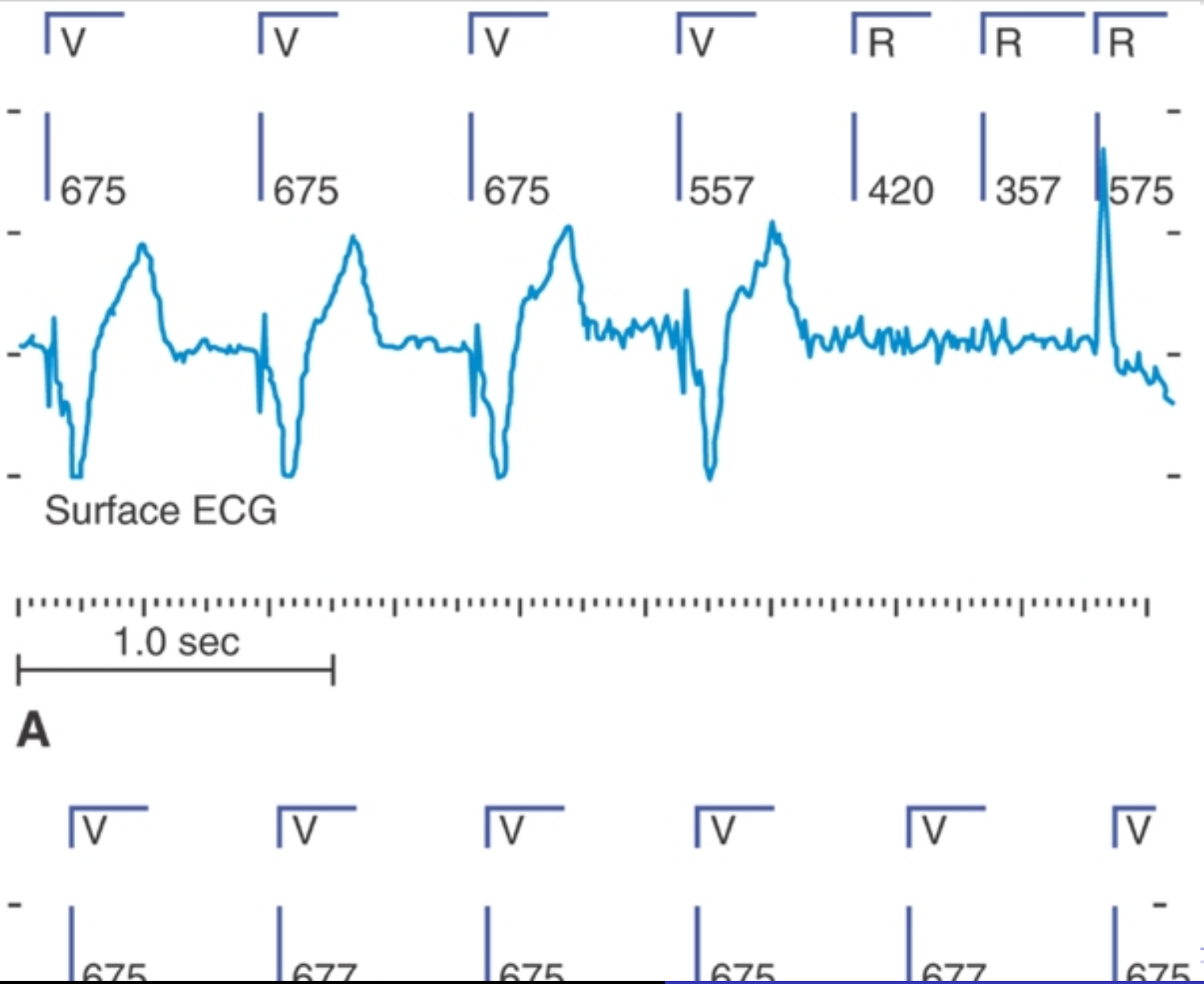
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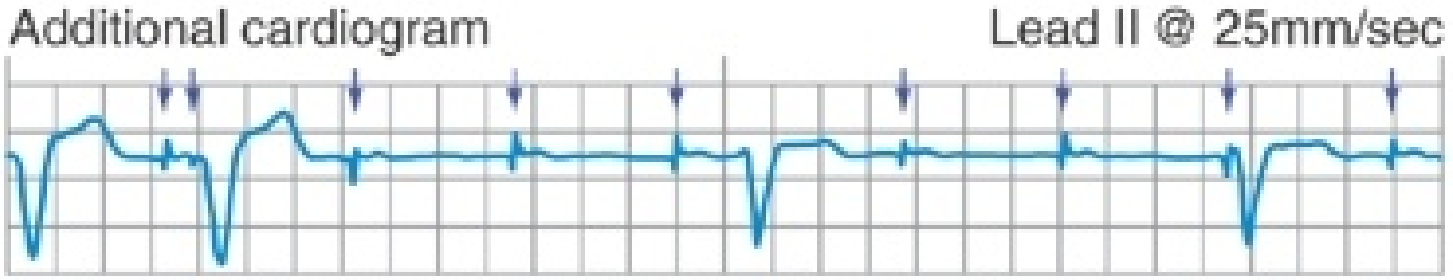



**A**

Mode: DDD Rate: 70 ppm A-V Delay: 200 msec
Magnet: TEMPORARY OFF

**ECG/IEGM PARAMETERS**

| | |
|---|---|
| Surface ECG | ON |
| Surface ECG Gain | 4.0 mv/div |
| Surface ECG Filter | ON |
| Intracardiac EGM | OFF |
| Intracardiac EGM Gain | 2.5 mv/div |
| Chart Speed | 25.0 mm/sec |

# Open Circuit

- Lead fracture
- Loose set screw
- Air in pocket

# Other causes

- Battery depletion
- Recording artifact

# Failure to capture (spike present)

# Lead dislodgement

- Micro-dislodgement
- Macro-dislodgement
- Perforation

# High threshold

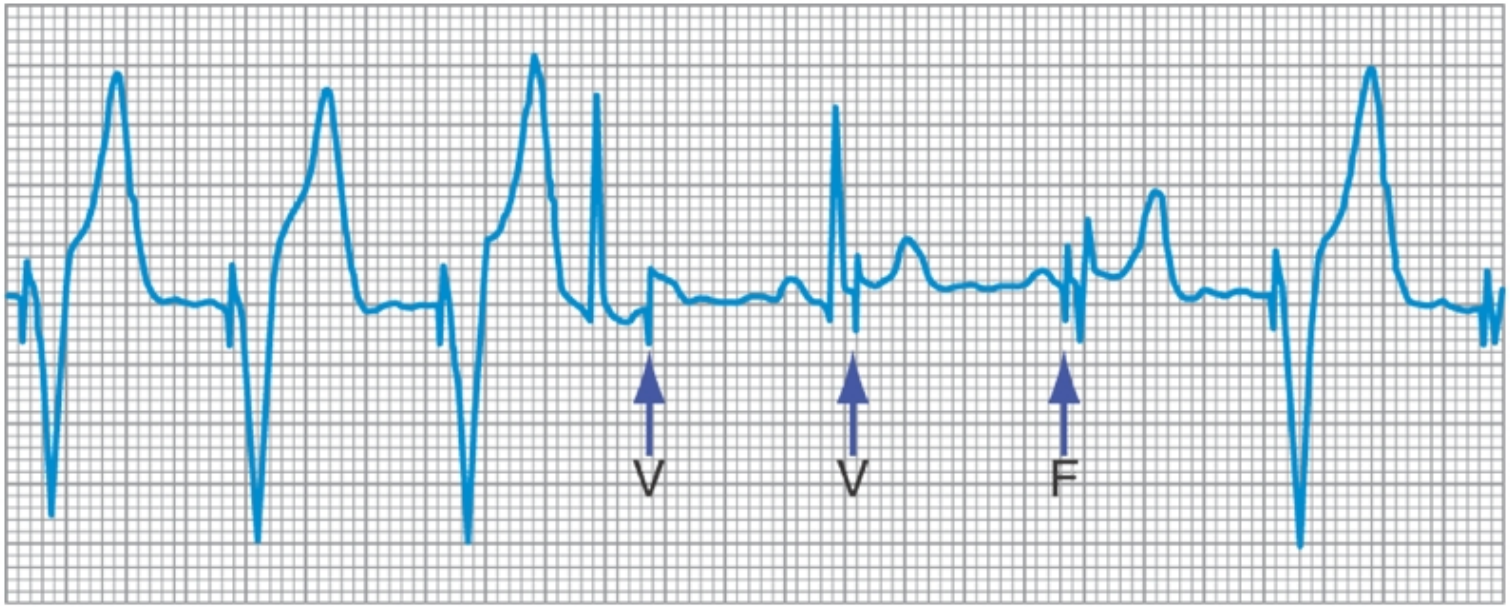
- Initial threshold elevation
- Increase in chronic threshold

# Battery depletion

Battery depletion prevents delivery of adequate output

# Functional non-capture

- True undersensing
- Functional undersensing



# Failure to sense

# Causes

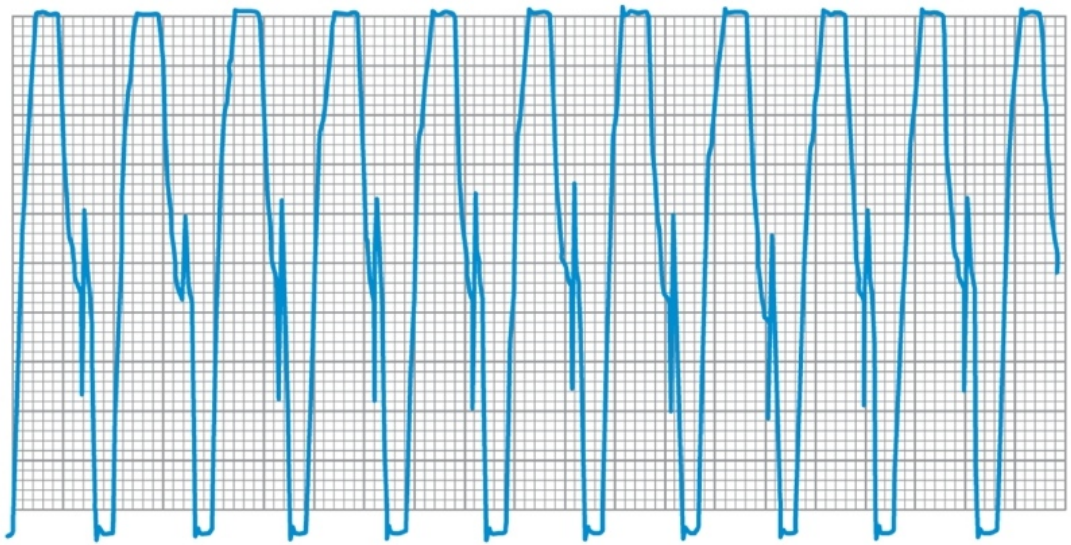
- Poor intrinsic signal
- Battery depletion
- Lead dysfunction
- Fusion and pseudofusion

# Pacing too fast

# Causes

- Rate modulation
- Tracking in dual chamber pacemaker
- Pacemaker mediated tachycardia
- Runaway pacemaker

# Pacemaker mediated tachycardia



# Conclusion

- Comprehensive evaluation including clinical findings, ECG and telemetry
- Identifying the cause of malfunction allows appropriate management