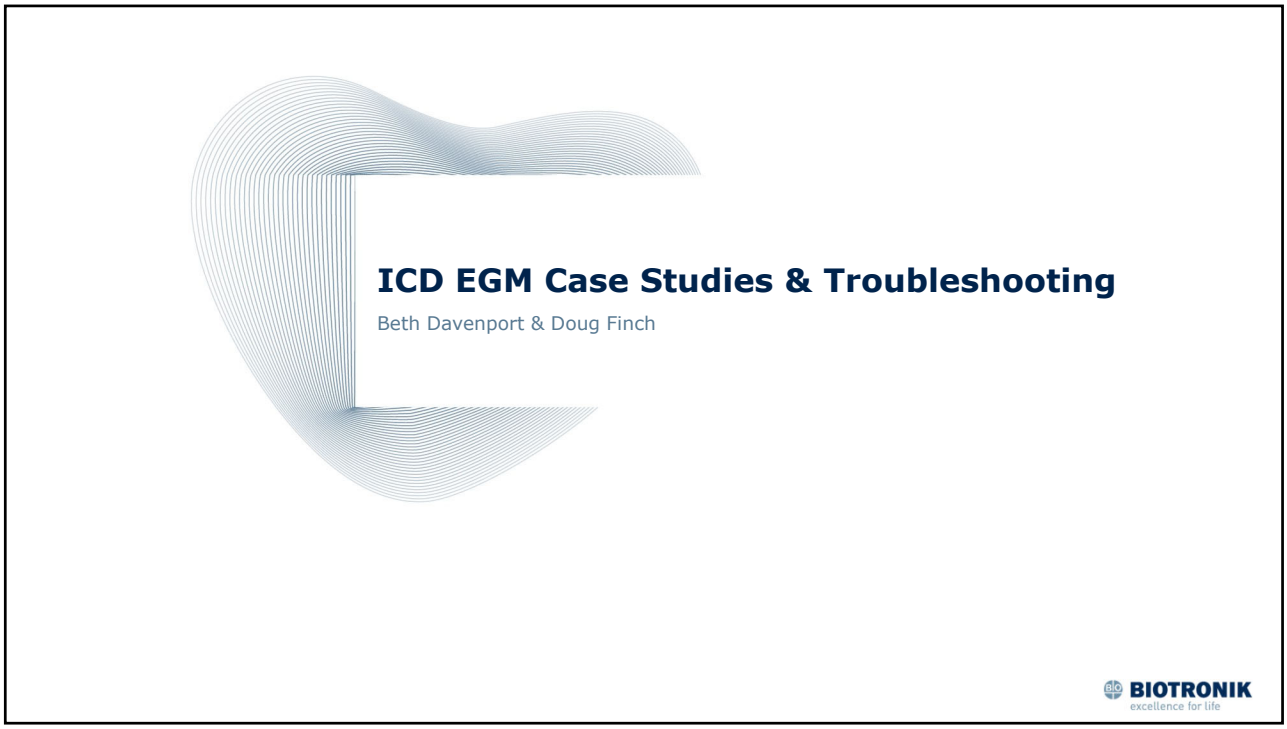
ICD EGM Case Studies & Troubleshooting
Beth Davenport & Doug Finch
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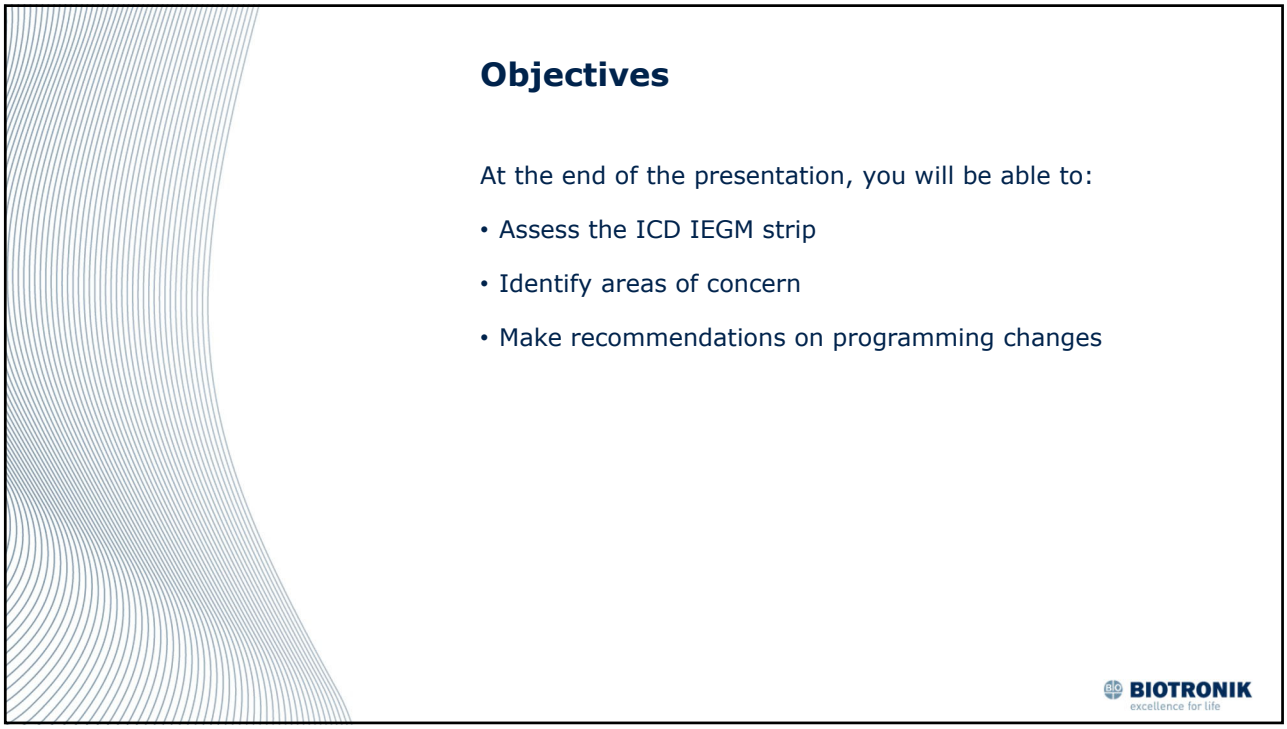
1


Objectives
At the end of the presentation, you will be able to:
• Assess the ICD IEGM strip
• Identify areas of concern
• Make recommendations on programming changes
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ICD Diagnostics – there to assist you

- IEGMs
- IEGM Channel Markers
- Interval plots
- HR histograms
- Lead Trends

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ICD EGM Analysis – A step by step approach

1. What is the rhythm?
   - Vs > As?
2. In what zone was detection met?
3. Is it a true arrhythmia, mechanical failure or electromagnetic interference (EMI)?
4. What therapies were delivered by the ICD?
5. Did therapy successfully terminate the arrhythmia?
6. If not – Why?
7. Are there any programming changes needed?
8. Or – is there a need for medical intervention to address the underlying cause?
   - Medication adjustment
   - Lab work / electrolyte imbalances
   - Chest x-ray

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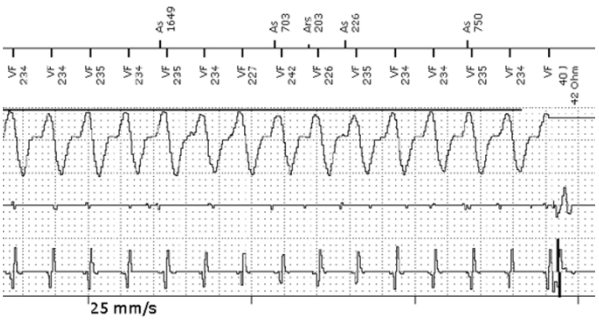
Common ICD Troubleshooting Issues

- RV lead fracture
- T-wave oversensing
- EMI
- Afib w/ RVR
- Dual tachy arrhythmias
- ATP acceleration of VT
- Slow VT



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RV (High-Voltage) Lead Fracture

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RV Lead Fractures on an ICD

- May be due to damage of the conductor(s) of a transvenous lead affecting the pace/sense circuit, the defibrillation circuit or both.
- RV lead alerts are very important for any ICD patient (as well as those who are pacer-dependent)
- Possible signs:
  - Changes in impedance (ohms)
  - Noise seen on EGMs
  - Inhibition of ventricular pacing
  - Changes in R-wave measurements (fluctuating)
  - Changes in RV capture threshold

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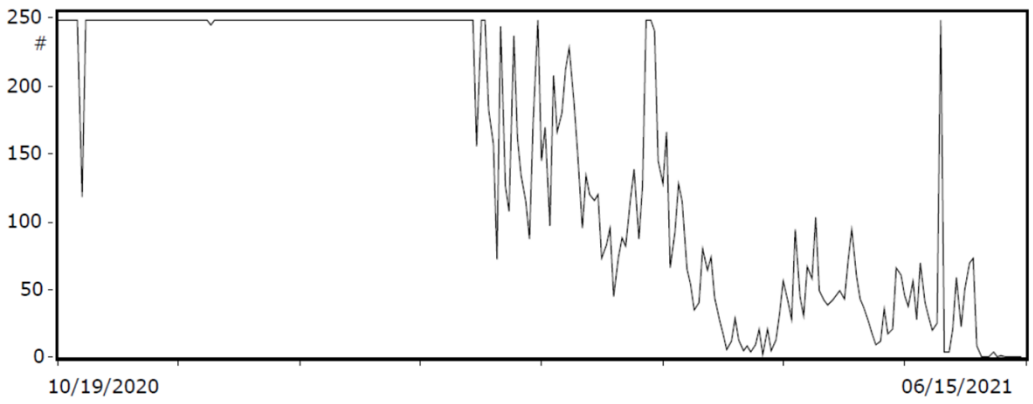
Short Interval Counter for Noise Detection



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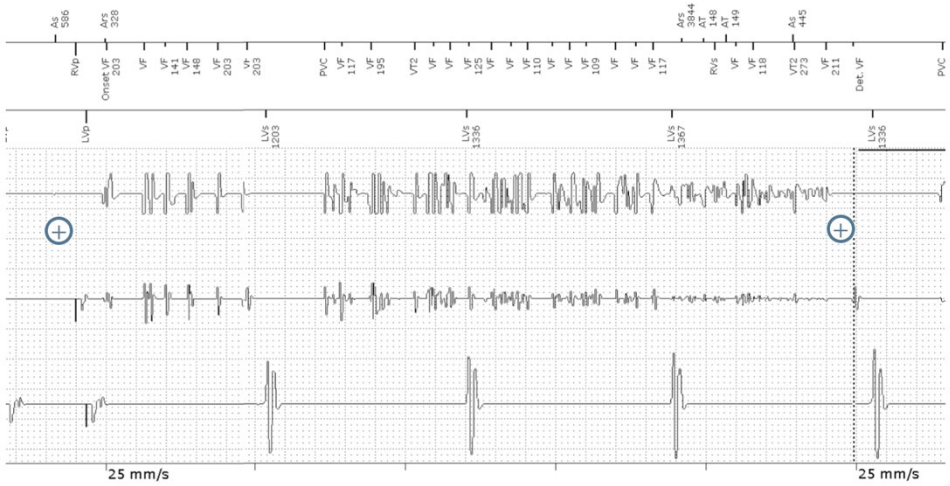
Noise – Short Interval Counter



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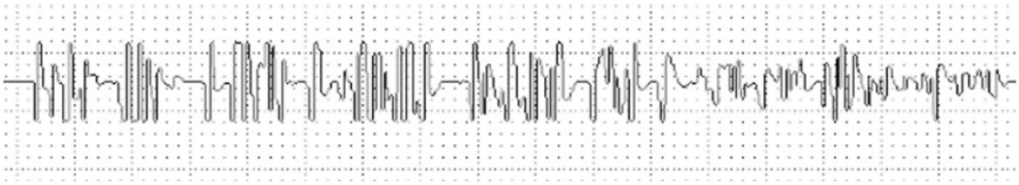
Noise – Appearance On An IEGM

How does noise present on the EGM and in the counters in the case of lead fracture?

1. Intermittent
2. High variability in frequency and amplitude
3. Non-periodic
4. Irregular



Source: BIOTRONIK Mastery

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Shock Impedance vs. Lead Impedance

Impedance is a measure of the resistance to the passage of the electrical current through the conductor.

- Increasing lead impedance measurements are possible with lead fractures because of the increased resistance to the electrical current flow within the lead.
- A decrease in lead impedance measurements are possible with insulation concerns because of the decreased resistance to the electrical current flow within the lead.

Note: There may NOT be an alert associated with an impedance change that is gradual – but overall trend should be considered in all cases.

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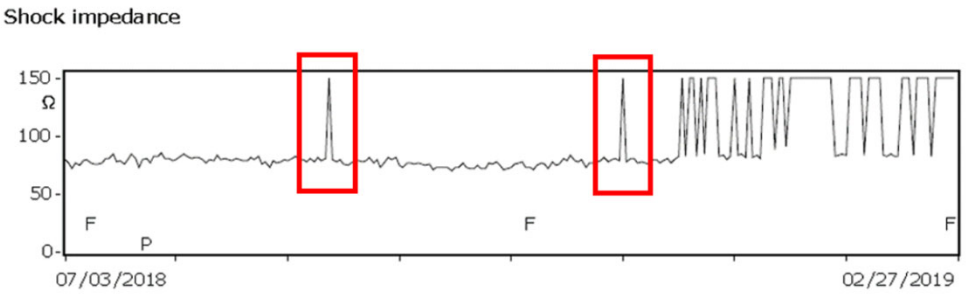
Lead Impedance Trends



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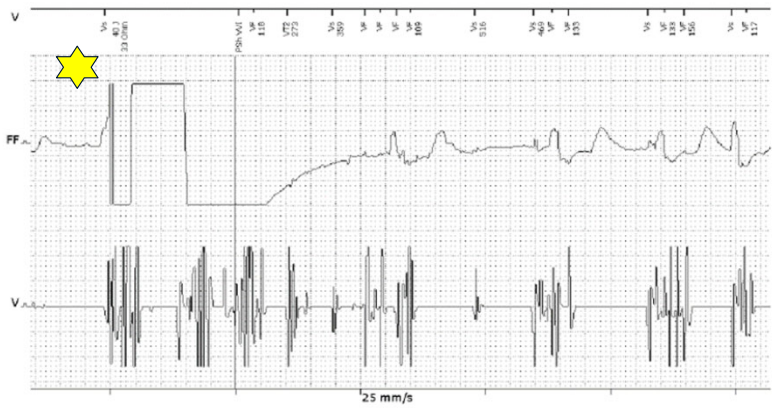
Inappropriate Shock Due To RV Lead Fracture

Example of lead fracture



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RV Lead Fractures On An ICD

Protect the patient & inform the EP MD

- If seen on a RM transmission – call the patient to assess any symptoms; were they recently in an accident? Do they have someone with them or are they alone?
- Review clinical history and be prepared to report on any tachy therapies received
  - Does the patient have an ICD for Primary or Secondary prevention?
    - May need a WCD as a bridge to RV lead replacement
- Advise patient to not move their arms anymore than necessary – do not drive themselves to the ER
- Apply clinical magnet if they are in clinic for in-person device check.
  - Keep them on surface ECG monitoring!
- Turn off tachy therapies before chest x-ray performed.
- Is this a fractured lead…or a connector issue? (recent implant?); pocket manipulation;
- Is this a dislodged RV Lead? (recent implant?)

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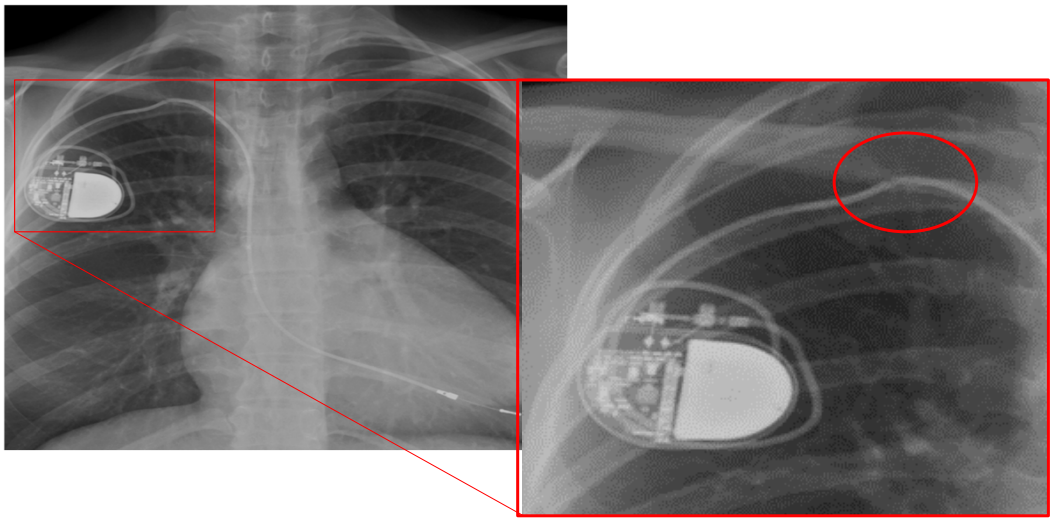
X-Ray Of Typical Lead Wire Fracture



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T-Wave Oversensing

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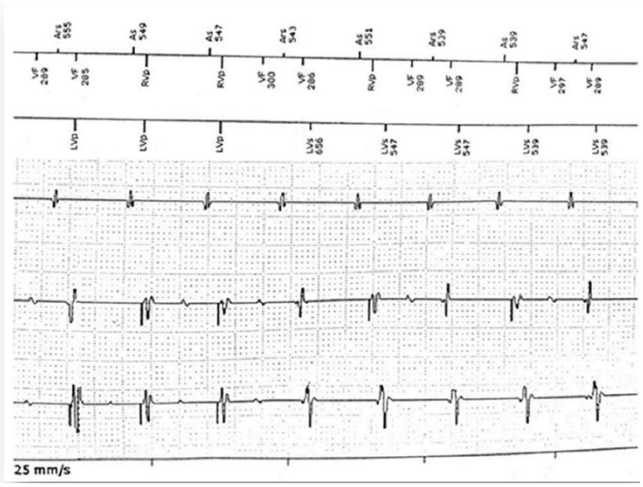
Addressing T-Wave Oversensing



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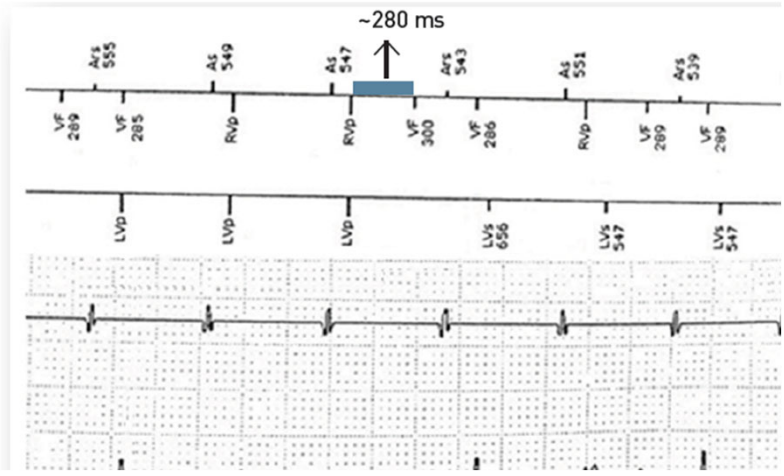
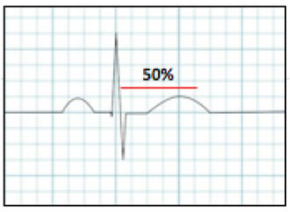
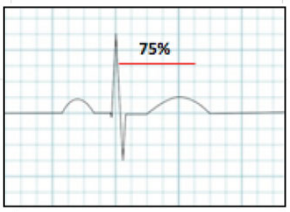
Addressing T-wave Oversensing





Sensitivity set to "Standard"



Sensitivity set to "TWS"

Source: BIOTRONIK Advanced Product Support

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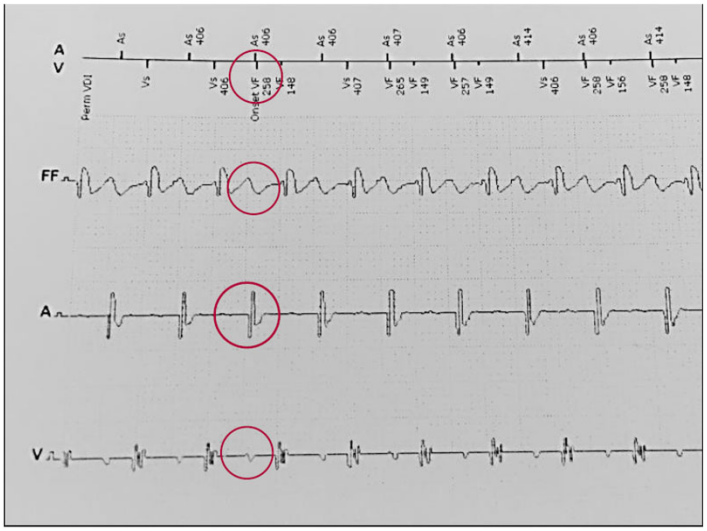
Addressing T-Wave Oversensing



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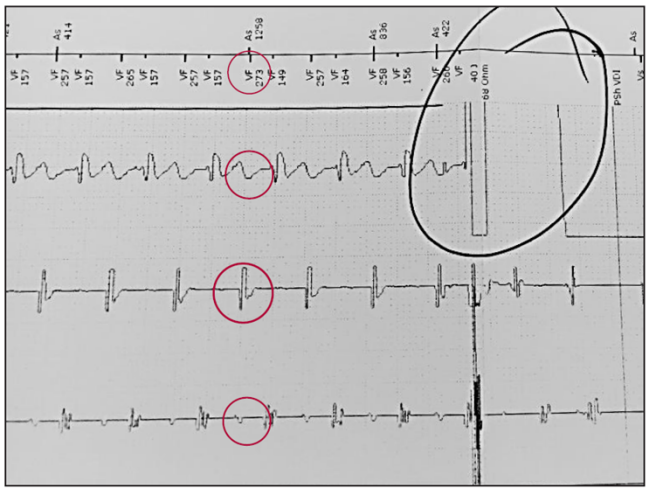
Addressing T-Wave Oversensing



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Electromagnetic Interference (EMI)

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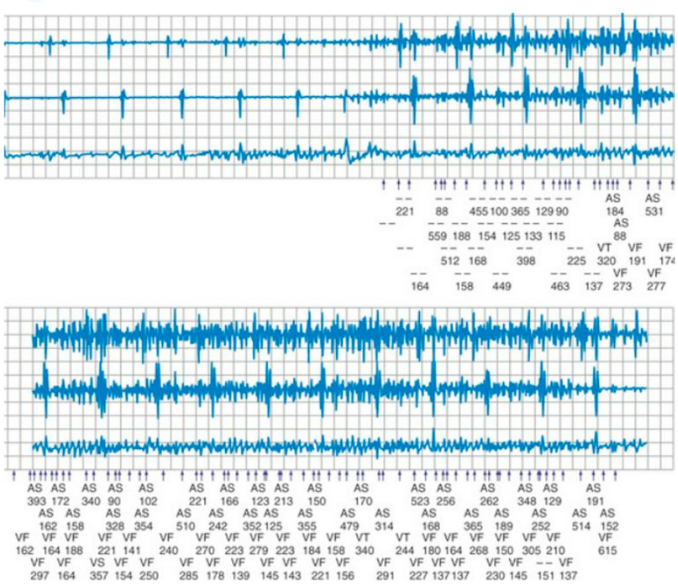
Addressing EMI



Thoracic Key online; "Electromagnetic Interference and CIEDs"; Kaszala; Daroly, Nazarian, Saman; Halperin, Henry.

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Afib with RVR in an ICD

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Afib With RVR In An ICD

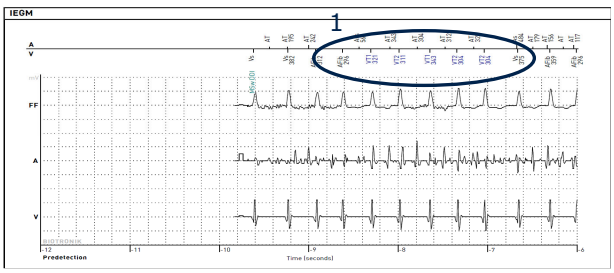
What does appropriate discrimination of Afib with RVR look like on an IEGM?

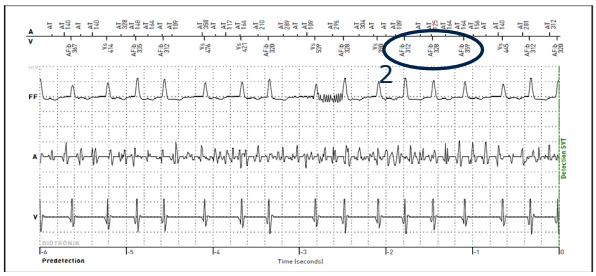
1. RV rate must be in a VT zone
   (Discriminators do not apply to the VF zone)
2. SMART is on (SMART annotations observed)
3. RV rate is unstable (+/-12% of 358ms = 3ms)

Recordings - Episode 1597:

General	
Episode number	1597
Episode type	SVT
Detection	Feb 19, 2018 8:51:25 AM
Termination	Feb 19, 2018 8:52:54 AM
Duration	1min 29s
Device settings no.	10
Detection	
Mean PP at initial detection [ms]	220
Mean RR at initial detection [ms]	358
Onset [%]	24 fulfilled
Stability [ms]	125
Redetection	---

3





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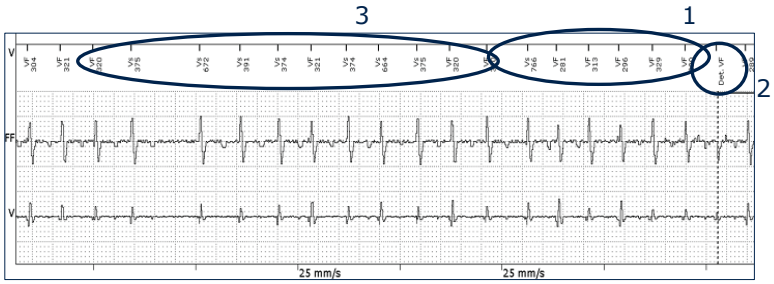
Afib With RVR In An ICD

What does inappropriate discrimination of Afib with RVR look like on an IEGM?

1. RV rate must be in a VT zone to discriminate but is in the VF zone (Discriminators do not apply to the VF zone)
2. Rate only discrimination is used in the VF zone
3. RV rate is unstable



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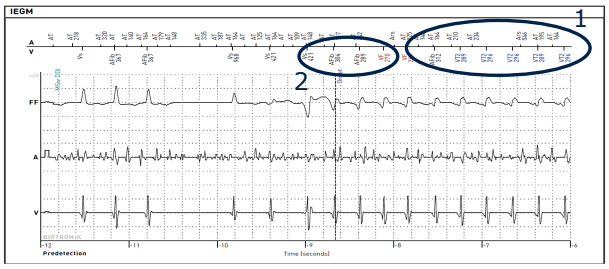
Afib With VT In An ICD

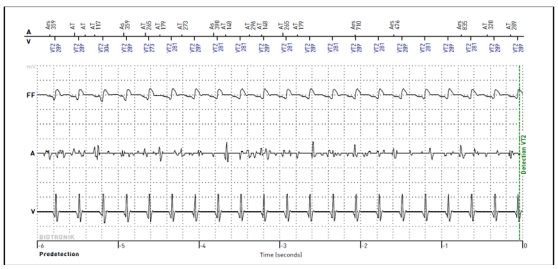
How does good discrimination of Afib with VT look on an IEGM?

1. RV rate must be in a VT zone (Discriminators do not apply to the VF zone)
2. SMART is on (SMART annotations observed)
3. RV rate is stable (+/-12% of 285ms = 4ms)

General	
Episode number	1595
Episode type	VT2
Detection	Feb 19, 2018 4:42:40 AM
Termination	Feb 19, 2018 4:42:48 AM
Duration	8s
Device settings no.	10
Detection	
Mean PP at initial detection [ms]	479
Mean RR at initial detection [ms]	285
Onset [%]	48, fulfilled
Stability [ms]	4
Redetection	---

3





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Afib With RVR In An ICD

Next steps for the patient with inappropriate Afib with RVR detection

- History of Afib or new diagnosis?
- Anticoagulation status?
- If pt. received a shock, did it cardiovert the Afib?
- Rate-control meds?
  - Did they miss any medications?
- Any recent changes in medications?
- Been sick (fever, vomiting, diarrhea)?
- Did they start dialysis or have a surgical procedure?
- Consider contacting Tech Support for programming recommendations to avoid inappropriate shocks moving forward and discuss with MD.

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ATP Acceleration Of VT

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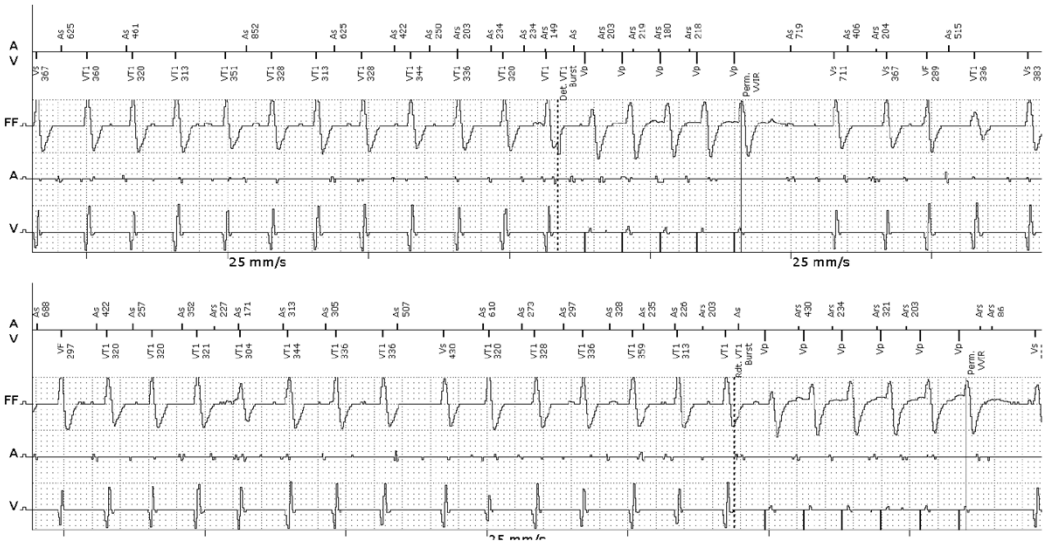
ATP Acceleration Of VT



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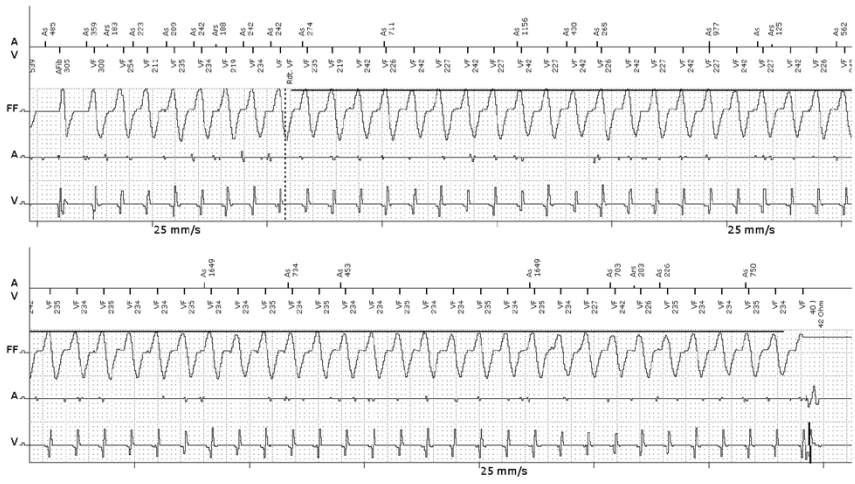
ATP Acceleration Of VT



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ATP Acceleration Of VT

Next steps for the patient with ATP that accelerated VT

- Review patient's medications, medical history, and discuss with patient if they have had any recent changes to their medications.
- Contact Tech support for recommendations on best options for programming to avoid ATP acceleration of VT in the future.
  - Some devices may automatically block ATP schemes that accelerate a rhythm until re-programming and this can also be explained by Tech support.
- Discuss Tech support's recommendations with MD as well as other patient information and make programming changes as directed.

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Slow VT (Below Therapy Zones)

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Slow VT (Below Therapy Zones)

- Can be difficult to identify on single lead ICDs.
- Will not have a recording (EGM) to help you.
- HR Histograms are often your only source of information to correlate with any possible complaints from the patient (palpitations, racing heart, dizziness, etc.)
- Slow VT can be due to medications and/or worsening heart failure.

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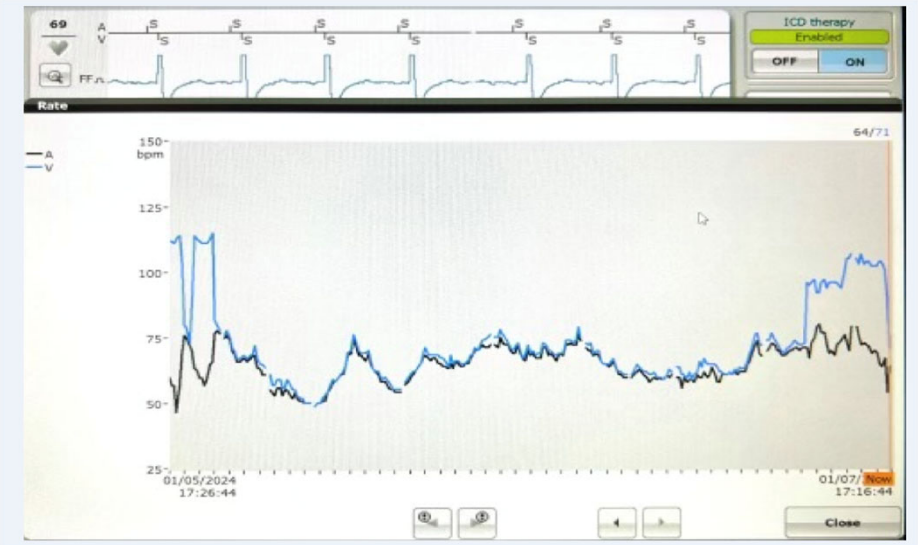
Slow VT (Below Therapy Zones)



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Slow VT (Below Therapy Zones)

- Can be easily missed.
- No VT/VF alerts
- May not have any EGMs to review
- Best "source" of information may be the patient reported symptoms and:
  - HR Histograms
  - AR and VR trends
  - Medical history & medication changes
- Patients with LVADs are often not symptomatic with VT

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Slow VT (Below Therapy Zones)

Next steps for the patient with suspected Slow VT

- Call Tech Support and review the diagnostics with them to confirm your analysis, and discuss recommendations for Tachy parameter reprogramming.
- Provide information to managing EP MD and discuss parameter changes.
- Possible parameter adjustment may include addition of a Monitor Only Zone to record any future slow VT events (with alerts).

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ICD Appropriate Therapy And Case Study

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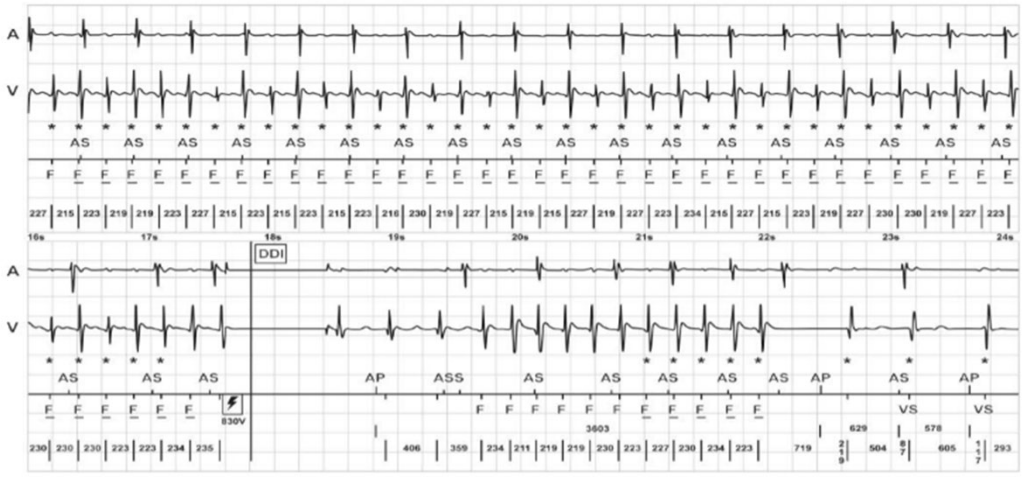
ICD Appropriate Therapy And Case Study
Appropriate Shock?



Paul A. Friedman MD, FACC, FHRS ; Melissa A. Rott RN ; Anita Wokhlu MD ; Samuel J. Asirvatham MD, FACC, FHRS ; David L. Hayes MD, FACC, FHRS. (2013). A Case-Based Approach to Pacemakers, ICDs, and Cardiac Resynchronization, Volume 1. Cardiotext. https://ebooks.cardiotextpublishing.com/pdfreader/casebased-approach-to-pacemakers-icds-cardiac-resynchronization197323

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ICD Appropriate Therapy And Case Study

Case Study: Dual Chamber ICD

22 yr. old female; Ischemic cardiomyopathy, myocardial infarction, LV aneurysm, and polysubstance abuse; ICD for secondary prevention of sustained monomorphic VT; Patient sent remote transmission after receiving multiple consecutive shocks that occurred during a time of emotional stress.

Settings:

VF Zone: 185 bpm

Therapies: one sequence ATP followed by eight 41J shocks

VT Zone: 150 bpm

Therapies: 3 sequences of ATP followed by six 41 J shocks

VT Zone detection enhancements: On

Initial: V rate > A rate

Afib rate threshold: 170 bpm

Stability: 20ms and Onset 9%

Sustained Rate Duration: 3 minutes

Paul A. Friedman MD, FACC, FHRS ; Melissa A. Rott RN ; Anita Wokhlu MD ; Samuel J. Asirvatham MD, FACC, FHRS ; David L. Hayes MD, FACC, FHRS. (2013). A Case-Based Approach to Pacemakers, ICDs, and Cardiac Resynchronization, Volume 1. Cardiotext. https://ebooks.cardiotextpublishing.com/pdfreader/casebased-approach-to-pacemakers-icds-cardiac-resynchronization197323

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ICD Appropriate Therapy And Case Study

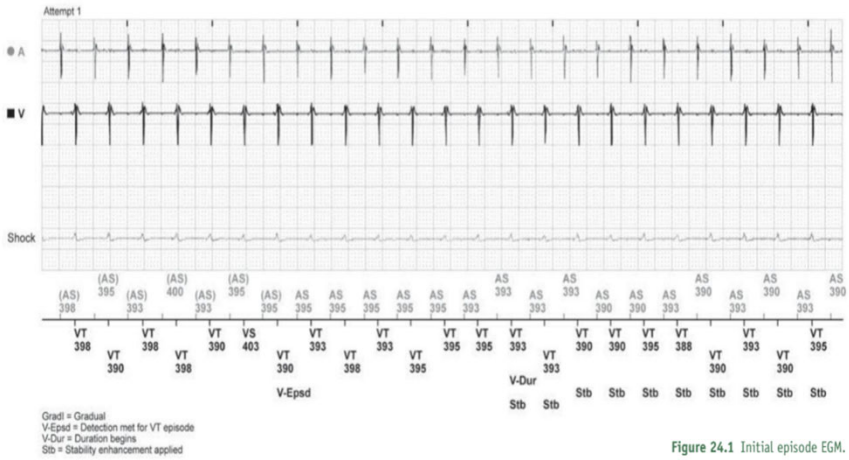

Figure 24.1 Initial episode EGM.

Paul A. Friedman MD, FACC, FHRS ; Melissa A. Rott RN ; Anita Wokhlu MD ; Samuel J. Asirvatham MD, FACC, FHRS ; David L. Hayes MD, FACC, FHRS. (2013). A Case-Based Approach to Pacemakers, ICDs, and Cardiac Resynchronization, Volume 1. Cardiotext. https://ebooks.cardiotextpublishing.com/pdfreader/casebased-approach-to-pacemakers-icds-cardiac-resynchronization197323

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ICD Appropriate Therapy And Case Study

Why was Therapy delivered?

1. Rhythm monomorphic VT?
2. Episode fell into VF zone with no detection enhancements?
3. Sustained rate duration timed out?
4. ATP treating atrial tachycardia?

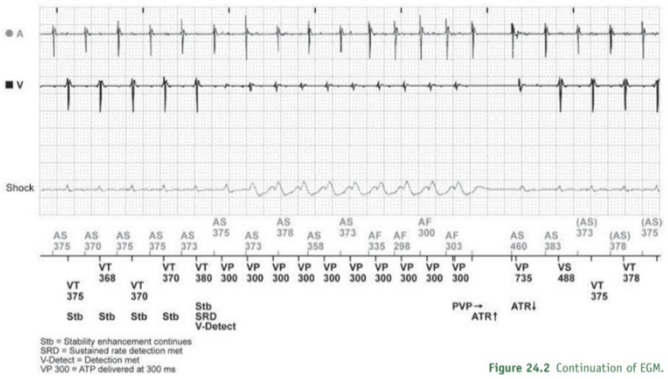

Figure 24.2 Continuation of EGM.

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ICD Appropriate Therapy And Case Study

Next steps for 22 yr. old patient with multiple shocks:

Discuss incident with the patient and ask:

- Has she been taking her medications as directed?
- What was happening when she received the shocks?
- Any recent surgeries? Procedures? Illness?

(Critical thinking)

- If patient taking meds as usual, and this is something that could happen again – then discuss reprogramming options with the MD.
- If patient has not been taking her meds as directed or there were other factors that could have caused the tachy events (such as drug abuse), then educate patient, encourage them, and provide these details to the MD.

Can there be adjustments made to tachy parameters to safely avoid shocks in the future?

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Questions?

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