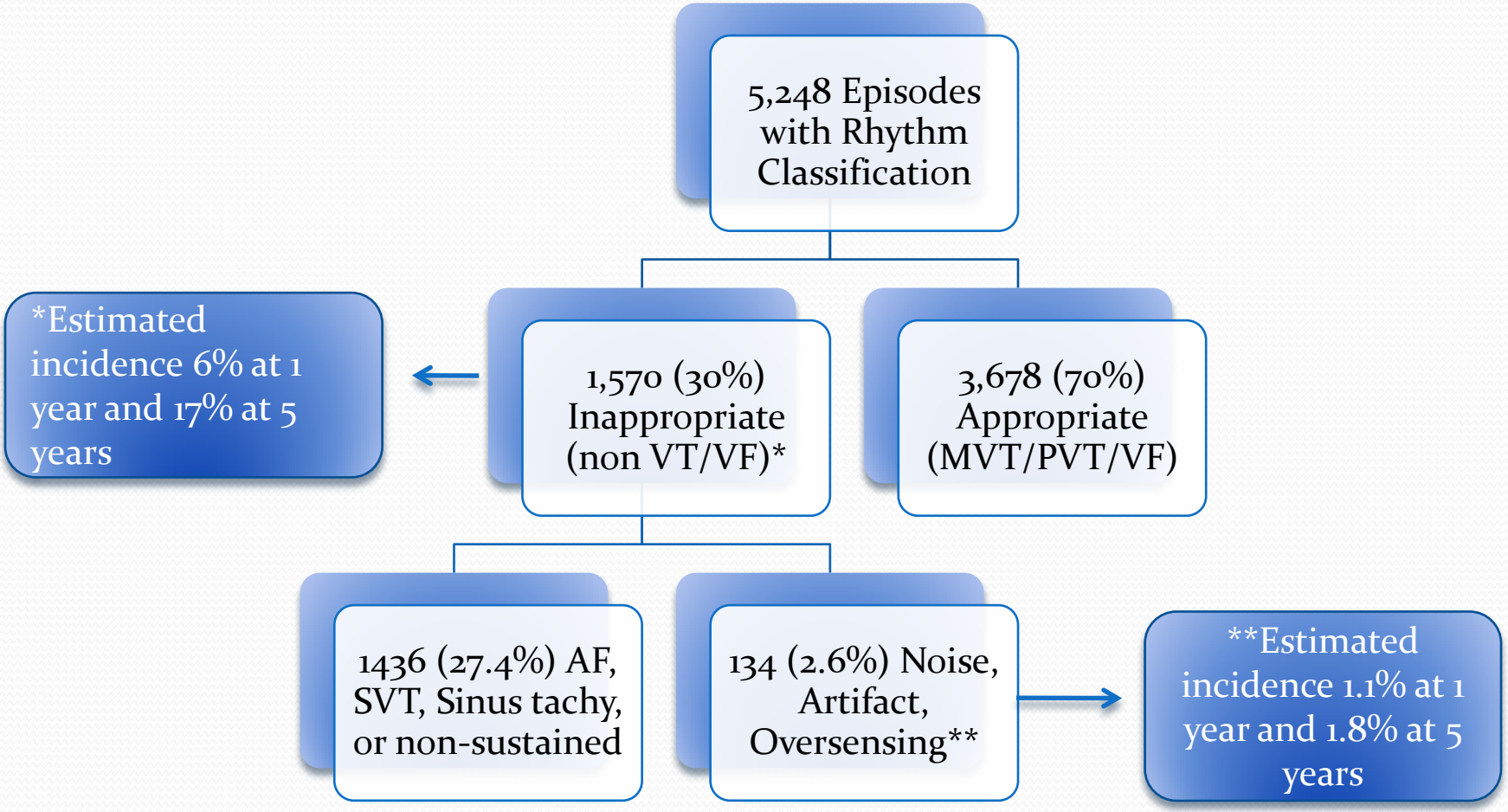
Management of Inappropriate ICD Shocks

12th Congress of the Vietnam National Heart Association
NhaTrang
October, 2010

Inappropriate Shocks

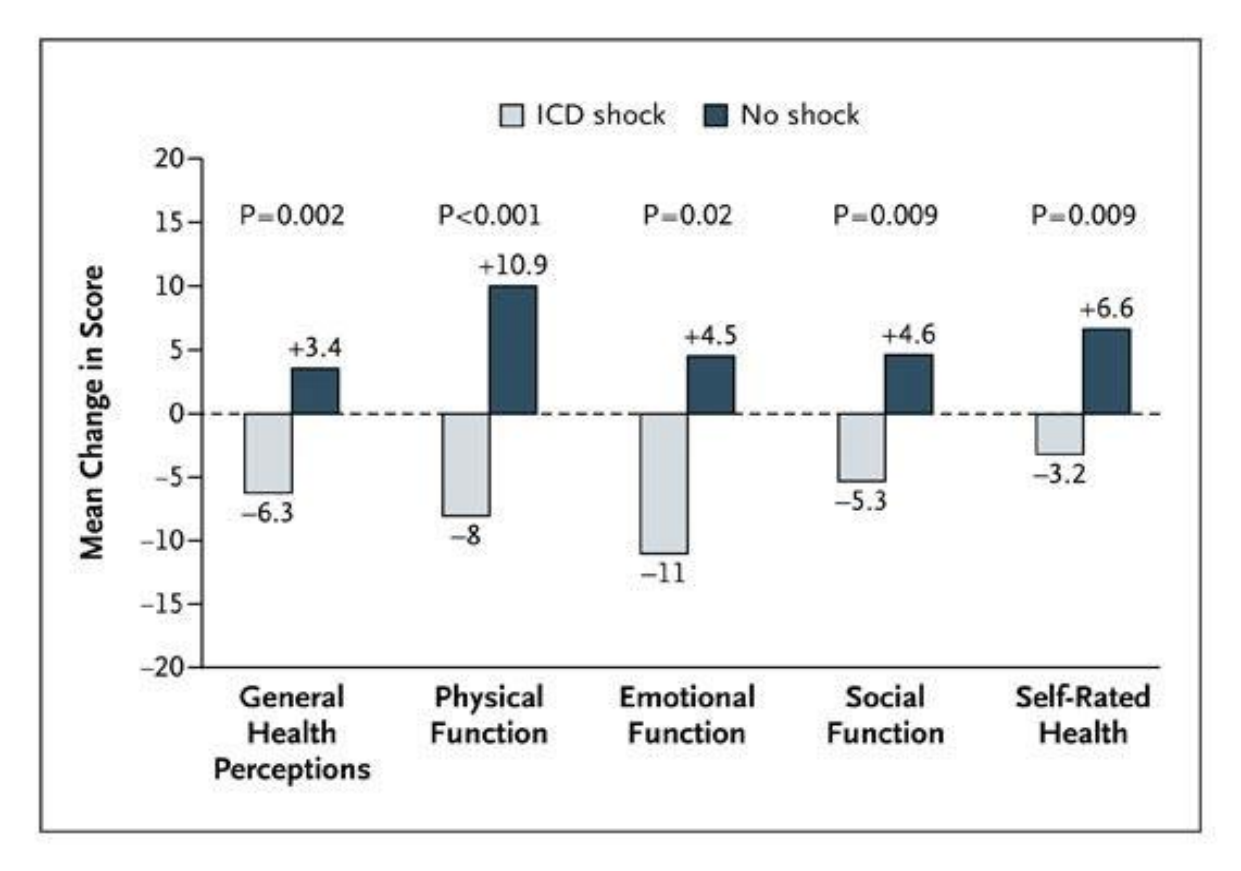
- Approximately 12-21% of ICD patients receive inappropriate shocks
- Causes:
  - Sinus tachycardia or supraventricular tachycardia
  - Atrial flutter and atrial fibrillation
  - Nonsustained arrhythmia
  - Noise/artifacts
  - Oversensing (T waves, P waves, R waves)
- Shock delivered for VT that was going to stop on its own or could have been treated by anti-tachycardia pacing instead

Adjudication of Shocks in the ATTITUDE-EGM Study



Powell B et al. The ALTITUDE EGM STUDY. HRS2010

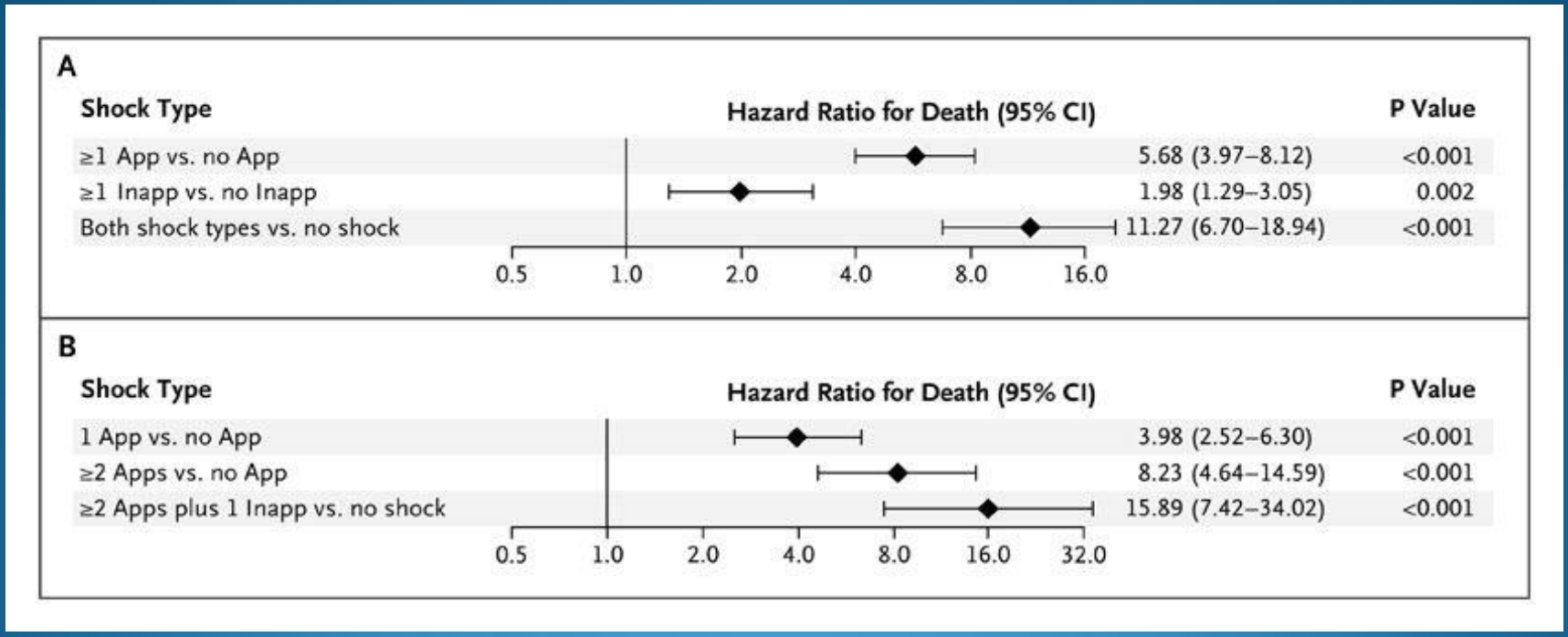
Impact of a Recent ICD Shock on Quality of Life



Patients who have had an ICD shock within the last month usually report a decrease in quality of life.

Mark DB et al. N Engl J Med 2008;359:999-1008.

Hazard Ratio for Death According to Shock Type in the SCD-HeFT Population

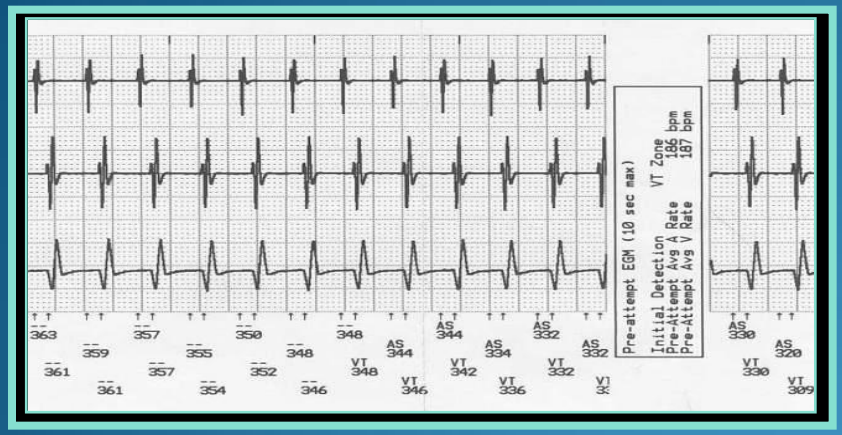


Inappropriate ICD shocks were associated with a 2-fold increase in mortality compared to when no shock has been delivered.

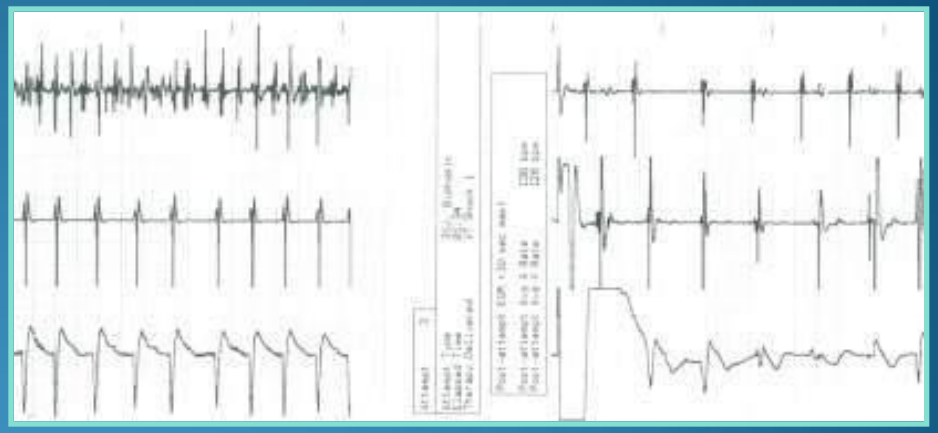
Poole JE et al. N Engl J Med 2008;359:1009-1017.

Potential Causes of Inappropriate Therapy

Sinus Tachycardia



Atrial Fibrillation



Inappropriate therapy is most commonly caused by ventricular rate exceeding the rate threshold

Ellenbogen K, Wood M. *Cardiac Pacing and ICD's.* Third Edition. Malden, MA: Blackwell Science Inc.; 2002: 435 - 436.

Methods for Avoiding Inappropriate ICD Shocks Caused by Sinus Tachycardia, SVT, or AF

- Programming the threshold rate for VT detection above the highest rate that the patient can develop during sinus tachycardia or atrial flutter or atrial fibrillation
  - Standard programming uses a rate cutoff of 170 to 180 bpm
- Pharmacologic slowing of sinus rhythm and ventricular response to atrial fibrillation
  - Usually with beta blockade
- Non-ICD therapy (ablation) for very slow VT, when VT rate overlaps with sinus rate

Discriminators for Avoiding Inappropriate ICD Shocks Caused by Sinus Tachycardia, SVT, or AF

- Sinus tachycardia
  - Suddenness of onset (no shock if onset is gradual)
  - AV relationship (no shock for 1:1 AV relationship)
  - R wave morphology (no shock if R wave during tachycardia resembles the sinus rhythm template)
- Atrial fibrillation
  - R wave morphology (no shock if R wave during tachycardia resembles the sinus rhythm template)
  - Regularity (no shock if the rhythm is irregular)

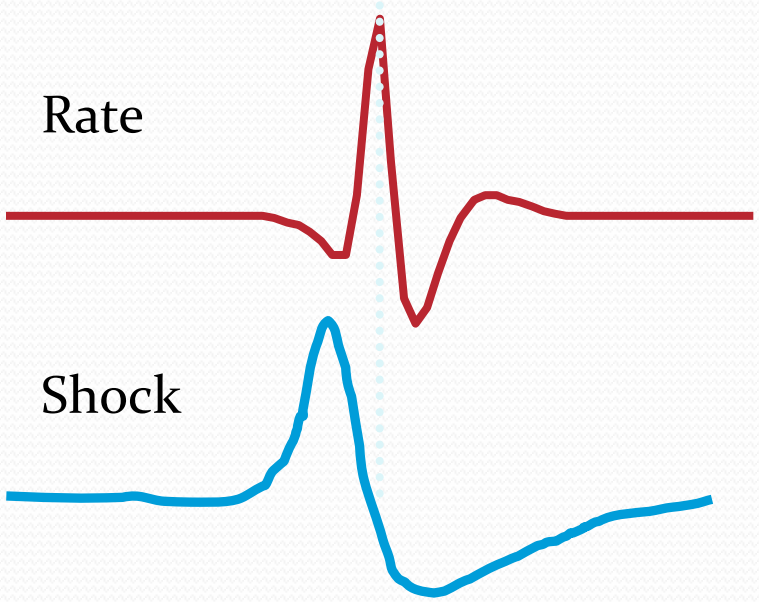
R Wave Morphology to Distinguish VT from Other Arrhythmias

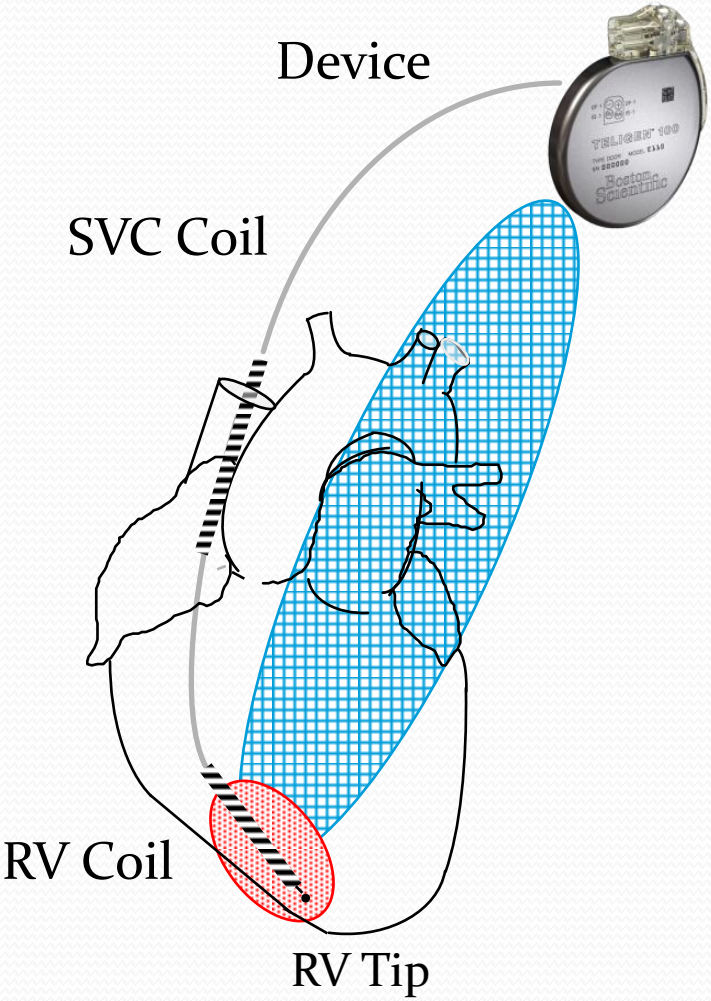
Rate Channel:

- Near-field electrogram (EGM) in the RV Apex (RV tip ➔ RV Coil)

Shock Channel:

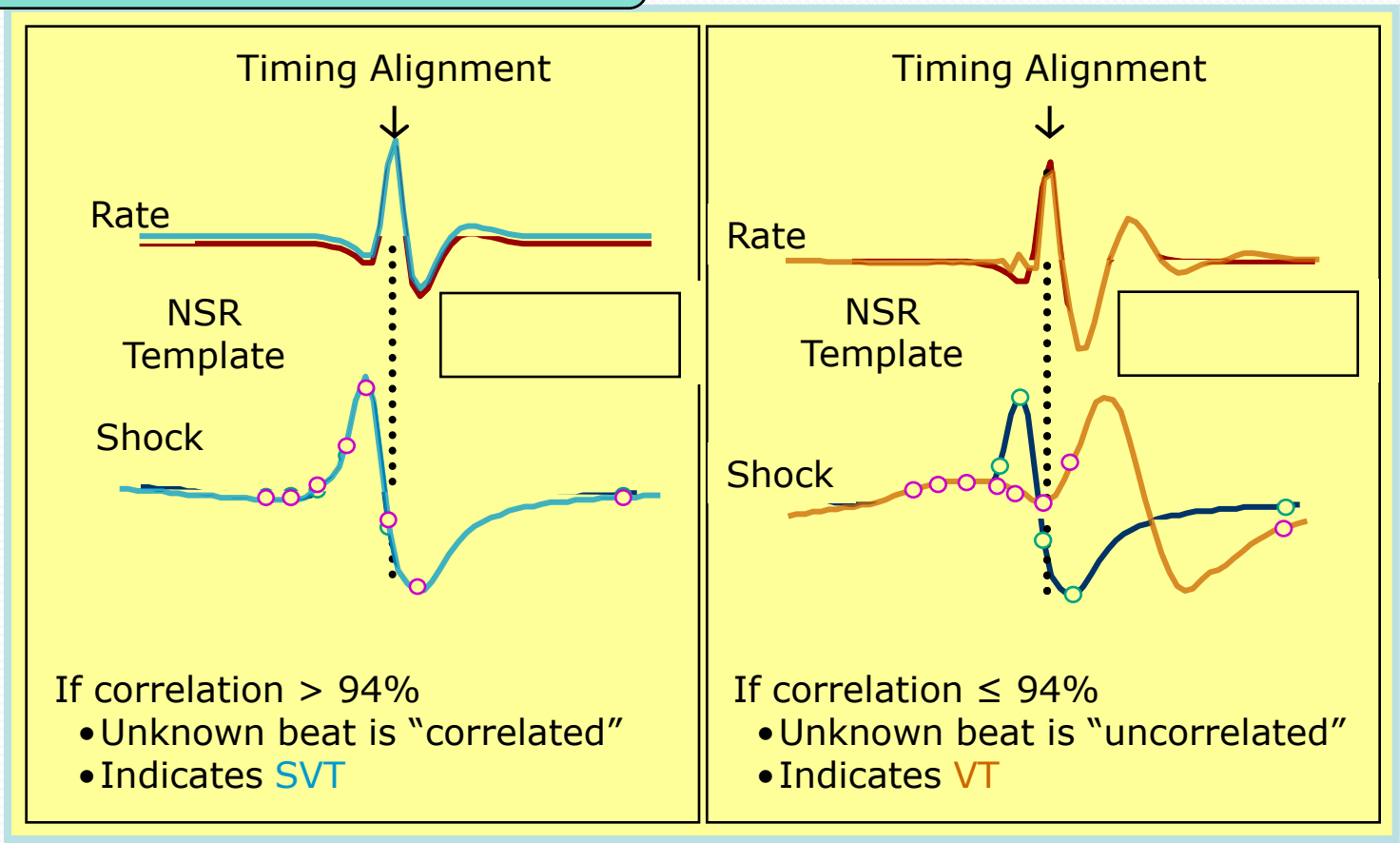
- Far-field EGM from the ICD defibrillation electrodes (RV Coil ➔ Device)



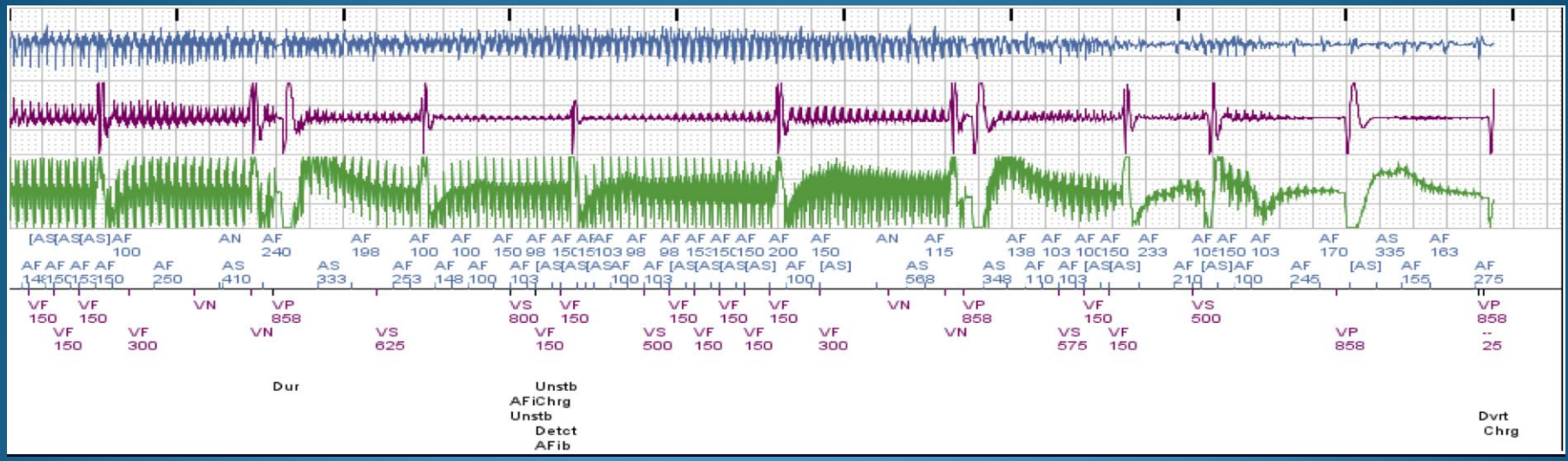


R Wave Morphology Method

Unknown Rhythm vs. Template



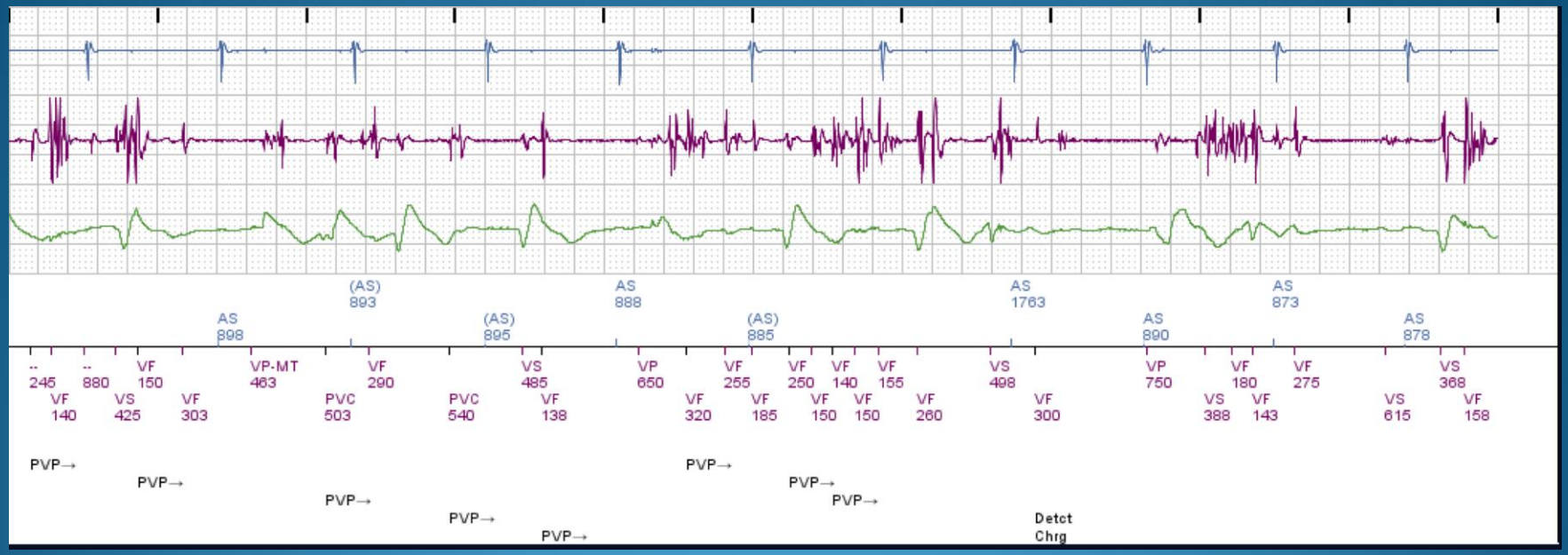
Electromagnetic Interference (EMI)



Artifact present on all leads/channels
Typically about 50-60 Hz
Treated by avoidance of the source of EMI

Powell B et al. The ALTITUDE EGM STUDY. HRS2010

Lead/Connector Malfunction



High frequency noise on one lead/channel

Often the noise is synchronous with R-waves

Must reconnect/reposition/ or replace the lead

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Diaphragmatic Noise

Very high frequency, not constant, respirophasic

May have to reposition the lead

Powell B et al. The ALTITUDE EGM STUDY. HRS2010

T Wave Oversensing

Double-counting produced by over-sensed signals that occur at a relatively fixed interval after the R wave

Can be very difficult to treat; may have to begin with lead repositioning

Powell B et al. The ALTITUDE EGM STUDY. HRS2010

P Wave Oversensing

Generally occurs because of dislodgement of the right ventricular lead into the right atrium

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R Wave Oversensing

Double-counting of R waves when Biotronic ICDs used in combination with integrated bipolar leads made by other manufacturers.

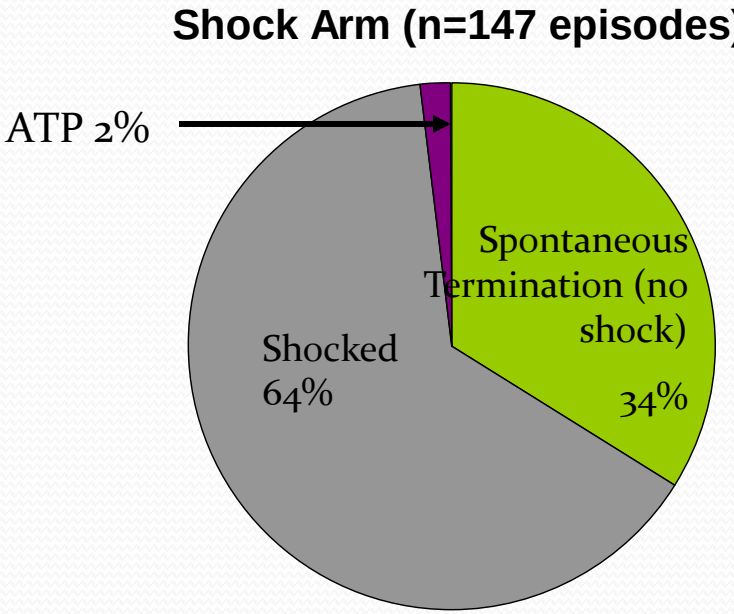
	True bipolar	Integrated bipolar	p
Biotronik	2/72	4/5	<0.0001
GDT/MDT	1/80	2/88	1

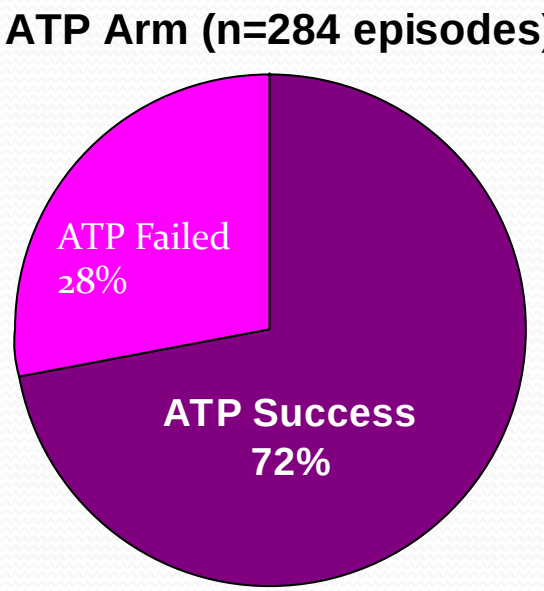
Integrated bipolar leads produce a wider signal than true bipolar leads. The Biotronic blanking period is only 80 ms, while the Guidant bp is 135 ms and the Medtronic bp is 110 msec.

Seegers J et al. Europace 2010.12:1460-1466

History of using ATP for fast VTs

PainFree II Rx Trial[1]





In the PainFREE II RX Trial 3 out of 4 fast VTs were successfully treated with ATP.[1]

[1]Wathen M, DeGroot P, Sweeney M, et al. for the PainFREE Rx II Investigators. Prospective Randomized Multicenter Trial of Empirical Antitachycardia Pacing Versus Shocks for Spontaneous Rapid Ventricular Tachycardia in Patients With Implantable Cardioverter-Defibrillators. Pacing Fast Ventricular Tachycardia Reduces Shock Therapies (PainFREE Rx II) Trial Results *Circulation* 2004; 110: 2591-96.

MADIT-RIT: Randomization Arms

- An on-going study of 1500 patients randomized to one of three rhythm detection programming:
  - Standard: Zone 1 (VT) 170 bpm, 2.5 s delay
    Zone 2 (VF) 200 bpm, 1.0 s delay
  - High rate cutoff: Zone 1 (VT) 170 bpm, monitor only
    Zone 2 (VF) 200 bpm, 2.5 s delay
  - Long delay: Zone 1 (VT-1) 170 bpm, 60 s delay
    Zone 2 (VT) 200 bpm, 12 s delay
    Zone 3 (VF) 250 bpm, 2.5 s delay

Conclusions

Inappropriate ICD shock therapy is a common and serious problem and is caused by a variety of mechanisms.

Proper management depends on the cause, and can involve:

- adjustment of medicines
- reprogramming of the ICD
- surgical revision of the ICD system

Sensitivity and Specificity of Rhythm Detection Algorithms (an Example)