Pacemaker Training Program
Special Functions
The Auto Mode Switch

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Special Programming that impacts the Anesthesiologist Part II

- Rate response mode
- **Automatic mode switch**
- Sleep mode
- Hysteresis
- Rate drop response
- Minimize ventricular pacing modes
- Noise reversion mode
- Pacer reset

Auto Mode Switch Objectives

- Definition
- What is the purpose
- How does it work
- How can you find the settings on a programmer
- How can you turn it off or modify it

Auto Mode Switch Definition

- Special program that changes the active pacing mode shortly after the initiation of an atrial tachyarrhythmia

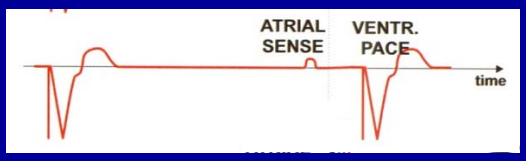
Auto Mode Switch Example

- Example:
  - Pacer programmed in DDD mode
  - Patient goes into A Fib
  - Pacer quickly changes to a DDIR mode

Why does the Mode Switch?

- Many pacers are programmed in the tracking mode, DDD
  - A sensed atrial event will be tracked with V-pacing if the intrinsic PR interval is longer than the pacemaker's sensed AV interval

A-Sense V-Tracking



Cardiac Pacemakers, SS Barold et al

Why does the Mode Switch?

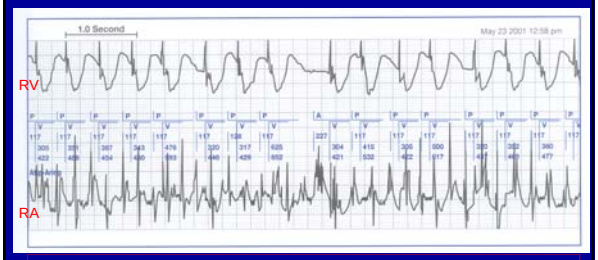
- What will happen to the ventricular pacing if the patient goes into atrial fibrillation?

Why does the Mode Switch?

- An atrial tachycardia can be tracked by the pacer to the upper tracking rate which would lead to continuous rapid ventricular pacing at a high rate

Pacemaker Electrogram of A Fib

DDD mode without Mode Switch



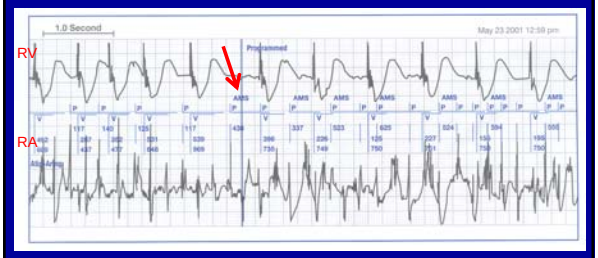
Any A Fib "P" wave sensed outside of the PVARP by the atrial sensing lead will be followed by (or tracked) by a ventricular pacing output after a sensed AVI.

What is Auto Mode Switch?

- Most pacers have a Mode Switch function that quickly converts to a non-tracking pacing mode to protect the patient from this rapid ventricular pacing

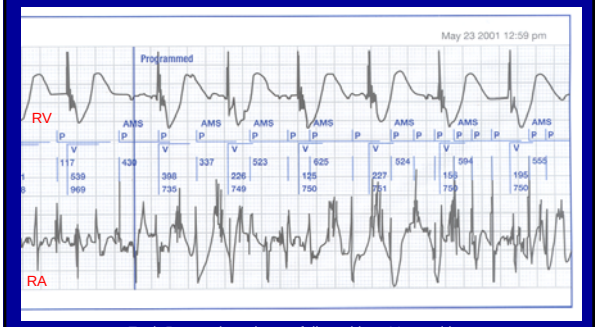
Mode Switch Effect

DDD with Mode Switch activation at arrow

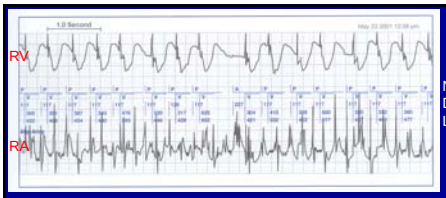


Ventricular pacing rate slows and becomes regular.

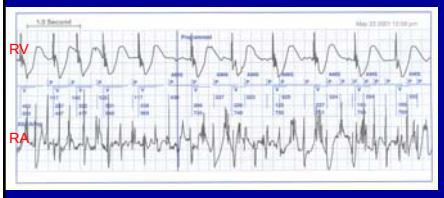
Mode Switch Effect Zoom



Each P-wave is no longer followed by a V-paced beat



No Mode Switch
DDD
LRL 60 URL 120



Mode Switch active
DDIR
LRL 70 MSR 130

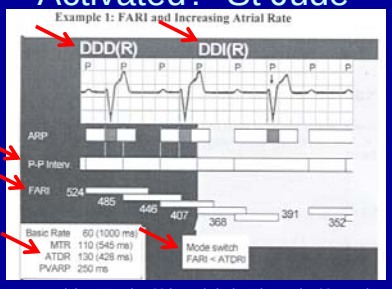
Automatic Mode Switching for SVT

- How exactly does the Pacemaker know when there is an atrial tachyarrythmia?

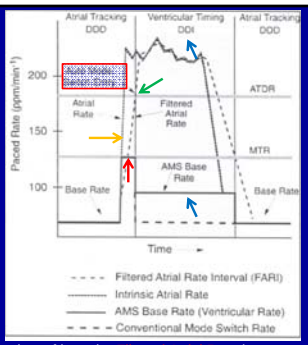
WARNING

- Buckle up your Chin Straps
- This is going to be hard to follow

How is the Mode Switch Activated? St Jude

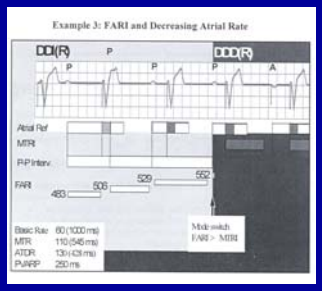


1. The pacer is DDDR and the ATDR is 130 beats/min (P-P interval=428 msec)
2. The atrial rate has increased which decreases P-P interval
3. The Filtered Atrial Rate Interval (FARI) begins to decrease by 39 ms/beat when P-P < FARI
4. When the FARI < Atrial Tachy Detection Rate Interval (ATDRI), the mode switch occurs
5. DDDR→DDIR and P waves are no longer tracked



1. Here is another view of how the Filtered Atrial Rate increases, but at a slower rate than the Actual Atrial rate.
2. Note the base rate, the MTR and the ADTR
3. The atrial rate accelerates quickly at the onset of Afib and V-pacing occurs at MTR
4. When FARI exceeds ATDR, the Mode Switch occurs
5. The V-pacing rate falls to the AMS Base Rate

Resolution of A-Fib



1. When the Atrial rate slows, FAR decreases and FARI increases
2. When FARI exceeds the ATDRI, the mode switch turns off
3. DDDR resumes

How the Mode Switch Works Recap

- The atrial lead measures the time interval between each atrial depolarization
- If there are enough short atrial intervals, atrial tachy is declared
- A non-tracking mode is activated
  - DDD→DDIR
  - DDDR→VVIR
  - DDD→DDI

What else does a typical Mode Switch Include?

1. Lower Rate Limit Increase

- Most devices increase the LRL when AMS is activated to compensate for the loss of the atrial kick
  - Medtronic is only manufacturer's Mode switch that doesn't include an option to increase the base rate

2. Add a Rate Response Mode

- Patients with an active AMS are in a non-trackable rhythm (e.g., A Fib)
- Most devices will add a rate response mode if the base mode does not have one

Auto Mode Switch Example

- Consider a pacer with DDD pacing and a LRL 60 and MTR 130 bpm and ATDR 160.
- If atrial HR >160 bpm, pacer mode switches to DDIR with a LRL 80 bpm and *USR* 130

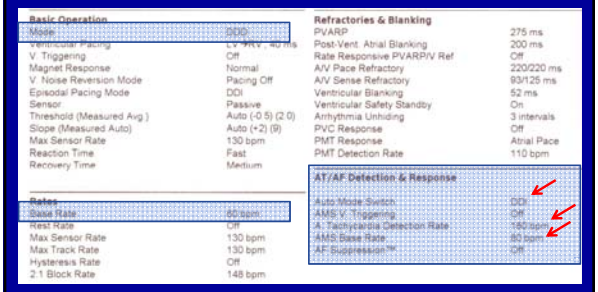
Take Home Message

- Acceleration of the atrial rate (from A-Fib or A flutter) will relatively quickly, but not immediately, lead to a mode switch.
- The mode switch will activate a non-tracking mode, usually with a slightly higher base rate and a RRM
- Resolution of the (A-Fib or cautery) will lead to a slightly delayed resumption of the base mode and lower base rate

Programmer Reports

- What information can you find on the programmer printed reports?

St Jude Mode Switch Example

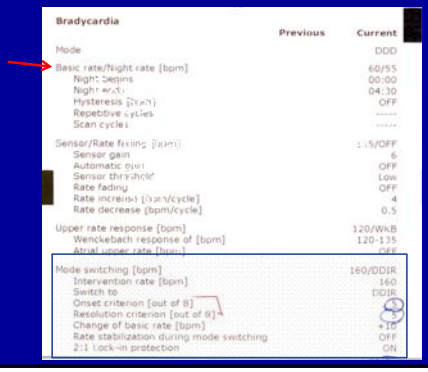


St Jude: Auto Mode Switch

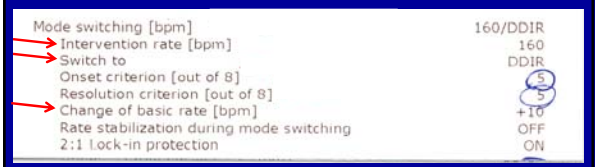
Bos Sci. Mode Switch Example

Boston Scientific: ATR Mode Switch

Biotronik Mode Switch Example

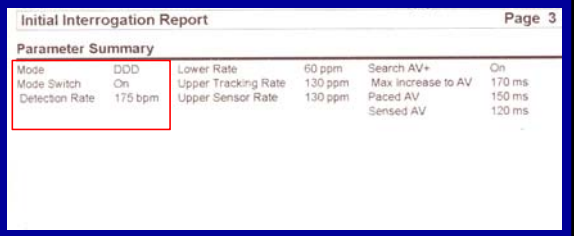


Biotronik Mode Switch Example



- If 5 out of 8 atrial sensed intervals are less than 375 ms (atrial rate of > 160 bpm), change to DDIR at 70 occurs

Medtronic AMS Example



Initial Interrogation Report — Page 3

Parameter Summary

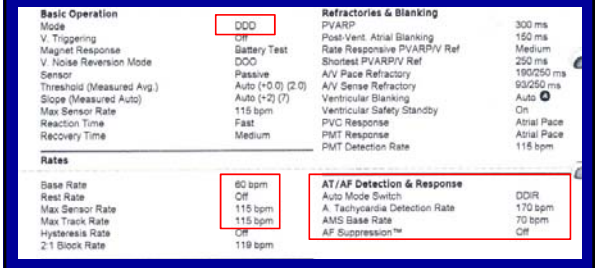
Mode	DDD	Lower Rate	60 ppm	Search AV+	On
Mode Switch	On	Upper Tracking Rate	130 ppm	Max increase to AV	170 ms
Detection Rate	175 bpm	Upper Sensor Rate	130 ppm	Paced AV	150 ms
				Sensed AV	120 ms

The only information reported is that the Mode Switch is ON and the atrial rate at which the switch occurs.
Medtronic DDD mode always converts to DDIR at the pacer's LRL, here 60.

Mode Switch and Cautery

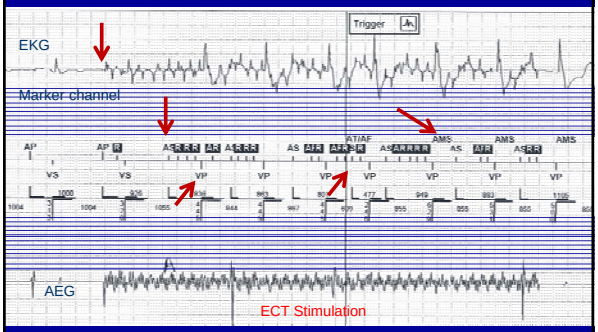
- If electrocautery is prolonged and sensed by the atrial channel, the pacer may interpret this as an episode of atrial tachycardia and mode switch temporarily

Mode Switch during ECT



Basic Operation		**Refractories & Blanking**	
Mode	DDD	PVARP	300 ms
V. Triggering	Off	Post-Vent. Atrial Blanking	150 ms
Magnet Response	Battery Test	Rate Responsive PVARP/V Ref	Medium
V. Noise Reversion Mode	DOO	Shortest PVARP/V Ref	250 ms
Sensor	Passive	A/V Pace Refractory	190/250 ms
Threshold (Measured Avg.)	Auto (+0.0) (2.0)	A/V Sense Refractory	93/250 ms
Slope (Measured Auto)	Auto (+2) (7)	Ventricular Blanking	Auto
Max Sensor Rate	115 bpm	Ventricular Safety Standby	On
Reaction Time	Fast	PVC Response	Atrial Pace
Recovery Time	Medium	PMT Response	Atrial Pace
		PMT Detection Rate	115 bpm
Rates			
Base Rate	60 bpm	**AT/AF Detection & Response**	
Rest Rate	Off	Auto Mode Switch	DDIR
Max Sensor Rate	115 bpm	A. Tachycardia Detection Rate	170 bpm
Max Track Rate	115 bpm	AMS Base Rate	70 bpm
Hysteresis Rate	Off	AF Suppression™	Off
2:1 Block Rate	119 bpm		

Mode Switch during ECT



One More Important Concept Related to the Mode Switch

- The patient's pacer may not be in the mode you think it is

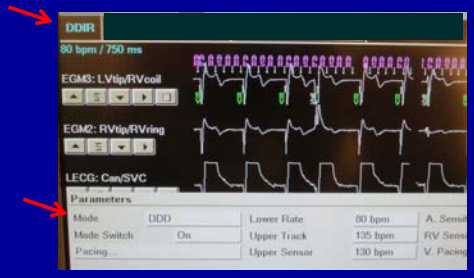
AMS/Rate Response Case

- 72 yo M booked for a CABG, AVR
- "Has DDD pacemaker" and HO Paroxysmal Atrial Fibrillation
- Heart rate increasing significantly during positioning and prepping
- Anesthesiologist concerned that patient is "light" but wonders if pacer is malfunctioning

AMS/Rate Response Case

- I interrogated the pacemaker

Medtronic Programmer



Even though the pacer is in the DDDR mode, the pacer is actually in DDIR due to the patient's A Fib rhythm as seen above.

AMS Rate Response Case

- In Mode Switch the Rate Response Mode turned on
- The accelerometer activated with patient movement and increased the paced HR
- I proved it to anesthesiologist by shaking chest near the pacer and HR promptly increased

Take Home Message

- A Mode Switch program will be active in most pacers programmed in a tracking mode.
- Make sure you know what the mode and pacing rate will be, especially if the patient has a history of AF/SVT
- The Mode Switch mode frequently contains an active Rate Response Mode and a higher base rate

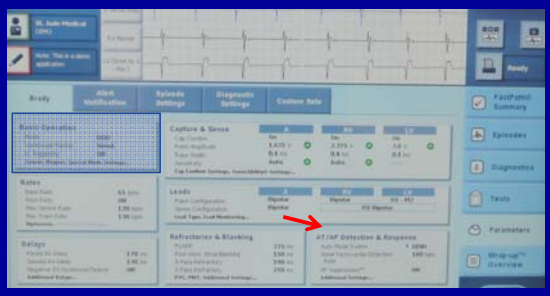
Medtronic Auto Mode Switch

- To get rid of the RRM with a Medtronic device you have two choices:
  - Turn the RRM OFF (risky if patient has AF)
  - Reprogram the base mode to DDI or VVI
    - This automatically turns off the Auto Mode Switch
    - Not ideal if patient presently is not in AF and tracking intrinsic P-waves

Programmers and the Auto Mode Switch

- How can you determine what the Mode Switch settings are?
- How can you change the Mode Switch settings?

St Jude Auto Mode Switch: AT/AF Detection & Response

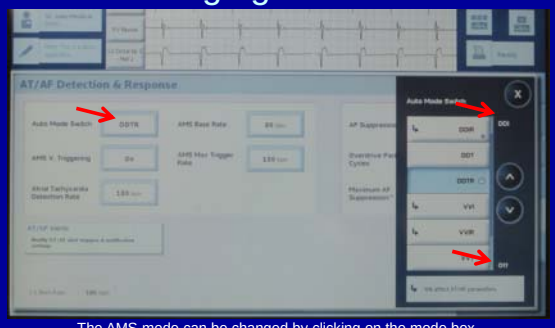


To assess and modify the Mode Switch function, click on the AT/AF Detection and Response box of the Parameters tab

St Jude Auto Mode Switch: Specific Settings

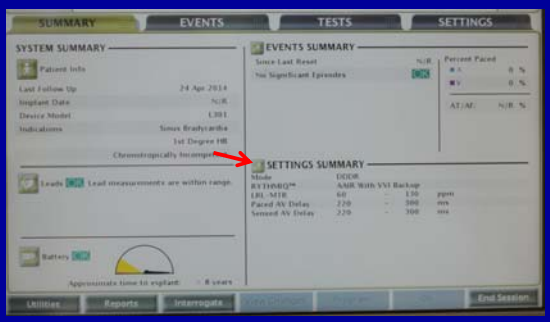
The mode is typically DDIR and the rate slightly higher than the base rate

St Jude Auto Mode Switch: Changing the Mode



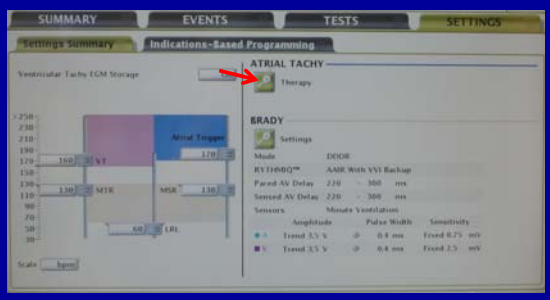
The AMS mode can be changed by clicking on the mode box
It is hard to see here but DDI and OFF are options.

Boston Scientific Mode Switch



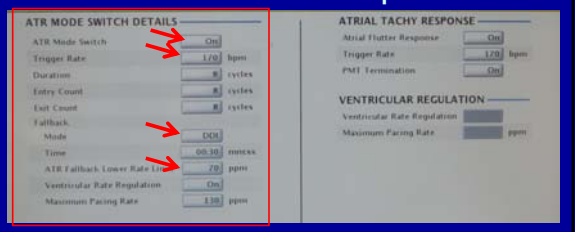
This is the initial screen from newer Bos Sci models. Click on Settings Summary

Boston Scientific Mode Switch

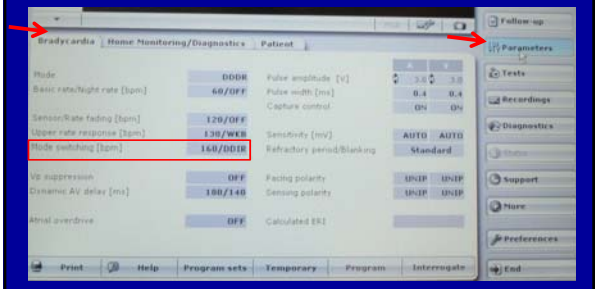


Then click on Atrial Tachy Therapy

Boston Scientific: ATR Mode Switch Specifics

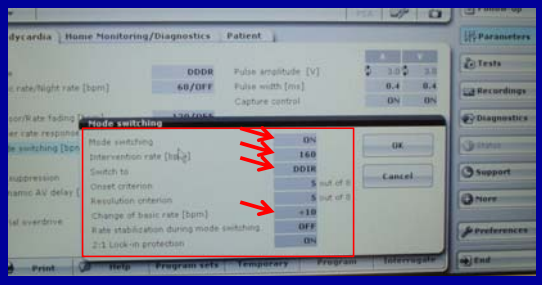


Biotronik Mode Switch



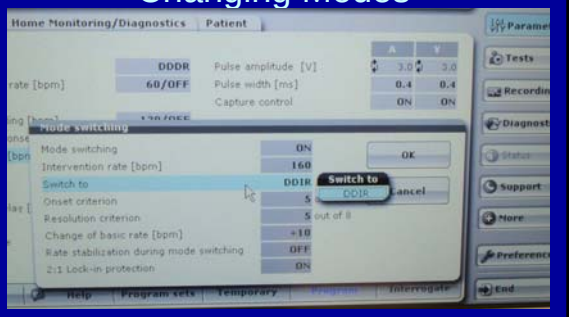
In the Parameters tab, you can find the Bradycardia Settings
Notice Mode Switching—the cutoff rate and the Mode

Biotronik Mode Switch



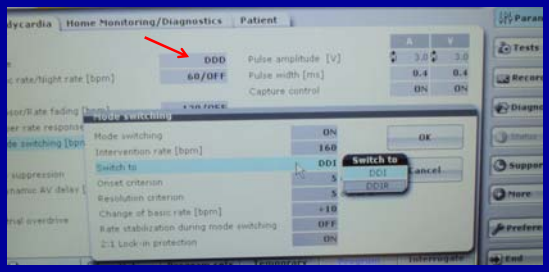
Here you see all the Mode Switch settings. The mode switch mode is DDIR and the rate is 70 (60+10).

Biotronik Mode Switch: Changing Modes



You cannot change to a mode without a RRM unless you convert the base mode to DDD first

Biotronik



When in the base mode of DDD, you will have the option to convert the Mode Switch to DDI.

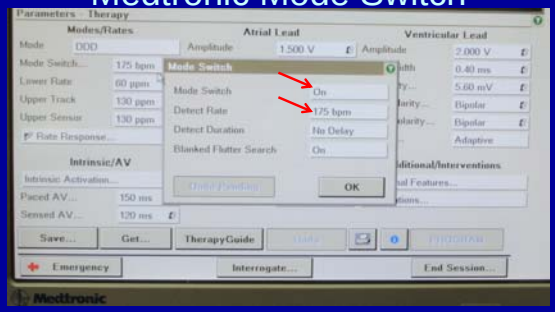
Medtronic Mode Switch

Click on Parameters

Medtronic Mode Switch

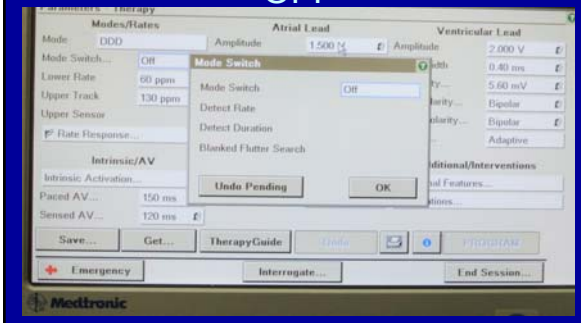
Then click on MODE SWITCH box

Medtronic Mode Switch



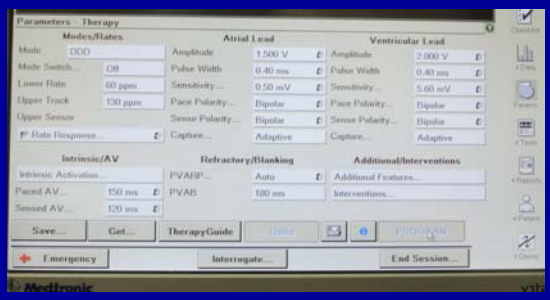
Here you see that Mode Switch is ON with detect rate=175, but there is not Mode info.
The mode is always DDIR (VVIR) at the base rate.
You may not change the mode or the rate.
But you can turn the Mode Switch OFF

Turning Medtronic Mode Switch OFF



The only way to get rid of the RRM associated with the AMS is to turn Mode Switch Off

Mode Switch OFF



But turning off the Mode Switch in a patient who is susceptible to AF would not be ideal. If the patient is in AF or goes into AF, you will have to program the pacer to DDI or VVI (this automatically suspends the Mode Switch)

AMS Summary

Manufacturer	Names	Change Mode?	Turn Off?
St Jude	AT/AF Dectection Response Auto Mode Switch	Yes	Yes
Bost Sci	A-Tachy Response	Yes	Yes
Biotronik	Mode Switch	Yes	Yes
Medtronic	Mode Switch	No	Yes

Mode Switch Summary

- The Mode Switch function protects patients from tracking (V-pacing) rapid atrial rhythms up to the Max Tracking Rate
- Most pacers or ICDs in the DDD(R) mode will have a Mode Switch programmed ON
- If the patient is in Afib/flutter, the mode switch will likely be activated which means the patient will likely be in a DDIR or VVIR mode with a slightly higher base rate

Mode Switch Summary

- Occasionally I will reprogram the mode switch mode to a mode that does not contain a rate response mode
  - Example: DDIR→DDI
- I do not usually turn OFF the Mode Switch function
  - One exception is with Medtronic—if I really do not want the RRM on and the patient is in AF, I would simply change to a VVI or DDI base mode (which obviates the need for AMS)

Mode Switch Summary

- The most important concept to take home is that for patients with a pacemaker in Afib in the DDD mode, the actual mode will not be DDD—it will likely be DDIR or VVIR.

Conclusion

- You now understand:
  - What the Auto Mode Switch is
  - What to be aware of in the OR if a patient is in A Fib
  - How to determine what the AMS settings are when looking at a device programmer report
  - How to use a programmer to find out the present settings and how to change them

The End