REMOTE CARDIAC DEVICE MONITORING – OPPORTUNITIES & CHALLENGES

Impact on patient care and pacemaker clinic flow

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OBJECTIVES

- Brief Overview of Cardiac Rhythm Management devices
  - pacemakers and implantable cardioverter defibrillator (ICD) and Cardiac resynchronization therapy (CRT) purpose and function
- Home monitor-overview of set up – video
- What can be monitored using the home monitor
- Pros and Cons of home monitoring
- Summary

WHAT ARE IMPLANTABLE CARDIAC RHYTHM MANAGEMENT DEVICES??

How is an ICD different than a pacemaker ?

How are pacemakers and ICD's different than CRT devices ?

How are these device implanted ?

QUICK REVIEW
CRM DEVICES

Permanent Pacemakers are implanted devices that treat

BRADYCARDIA

Pacemaker Components Combine with Body Tissue to Form a Complete Circuit THAT:

Senses the hearts own intrinsic beats

Paces or Inhibits at the programmed interval(rate)

Pacemaker can be single or dual chamber or Biventricular

1 or 2 or 3 leads in the right atrium and or right ventricle and or over the left ventricle

IMPLANTABLE CARDIOVERTER DEFIBRILLATORS

ICD's are implanted devices that treat **both**

BRADYCARDIA and Ventricular TACHYARRHYTHMIAS

ICD's can be single or dual chamber or biventricular

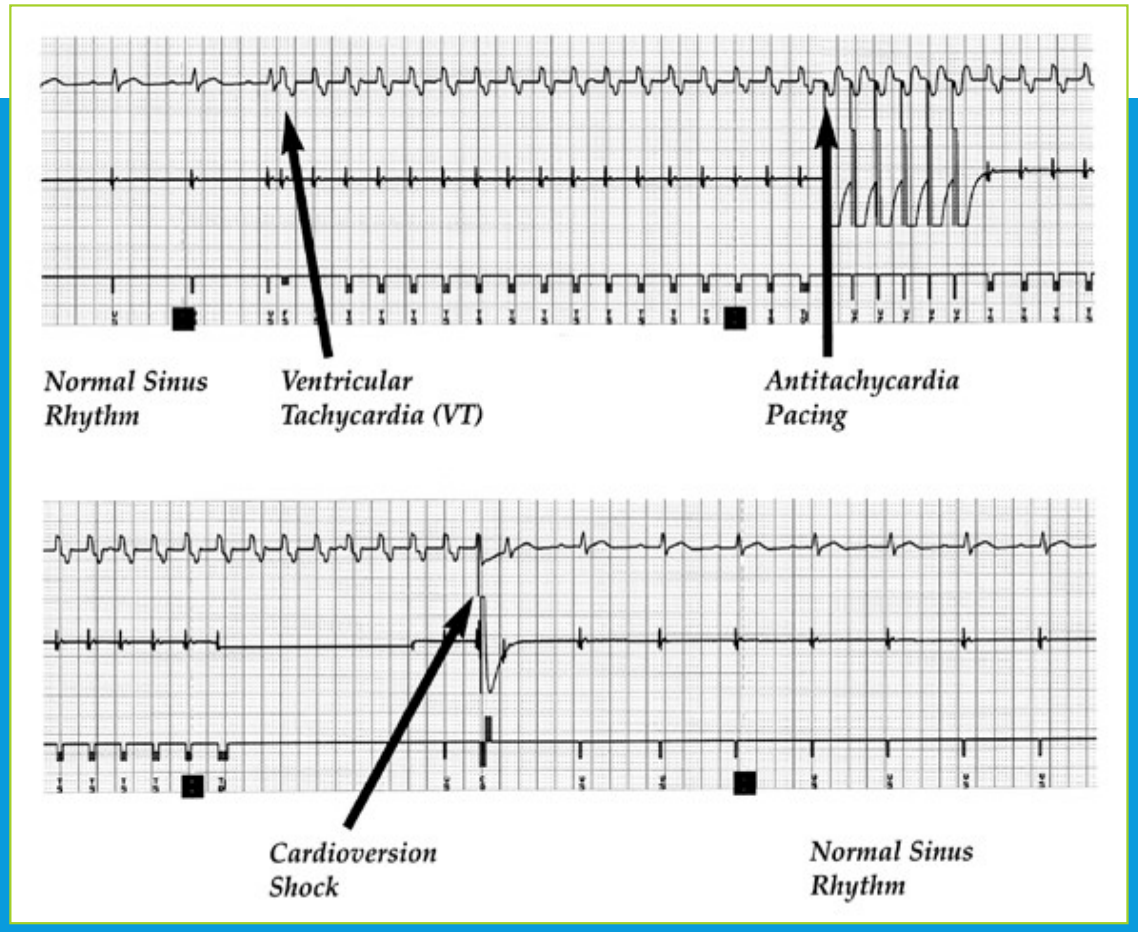
1 or 2 or 3 leads in the right atrium and or right ventricle and or over the left ventricle

ICD FUNCTION

ICD's

- **Treat Bradyarrhythmias with pacing**
- **Treat tachyarrhythmias using Tachyarrhythmia therapies**
  - **Defibrillation/Cardioversion**
  - **AntiTachycardia Pacing – ATP**

VENTRICULAR TACHYCARDIA



CARDIAC RESYNCHRONIZATION THERAPY DEVICES

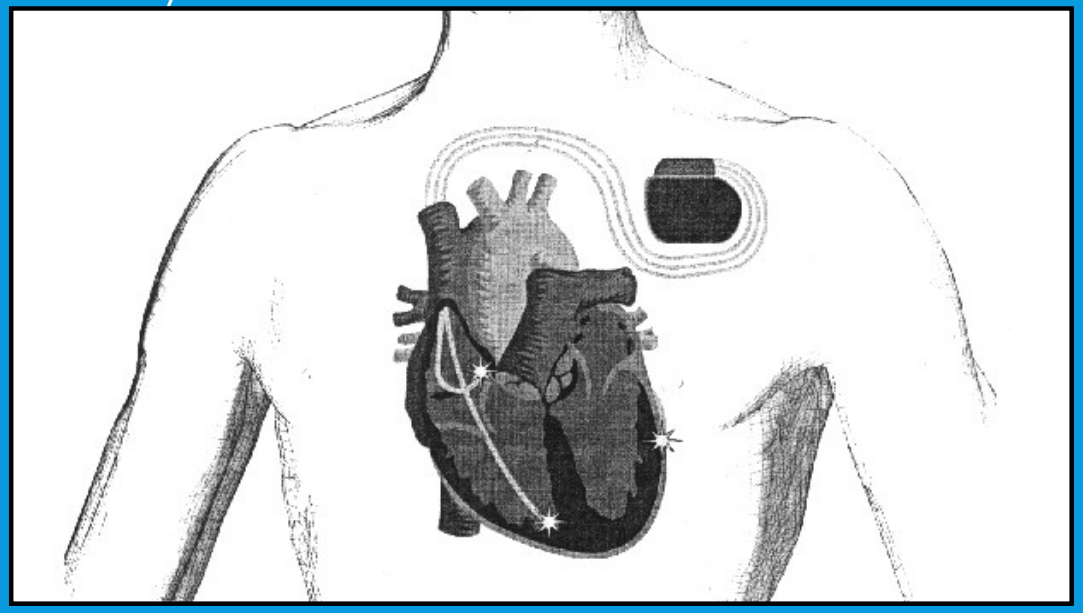
CRT Devices also call **BIVENTRICULAR** devices are *PACEMAKERS or ICD's* that pace both ventricles to provide resynchronization of the right and left ventricle in patients with:

- **CHF**
- **Wide QRS**
- **Ventricular Dysynchrony**

WHAT IS VENTRICULAR DYSYNCHRONY

ACHIEVING CARDIAC RESYNCHRONIZATION
MECHANICAL GOAL: PACE RIGHT AND LEFT VENTRICLES

- Standard pacing leads in RA and RV
- Specially designed left heart lead placed in a left ventricular cardiac vein via the coronary sinus

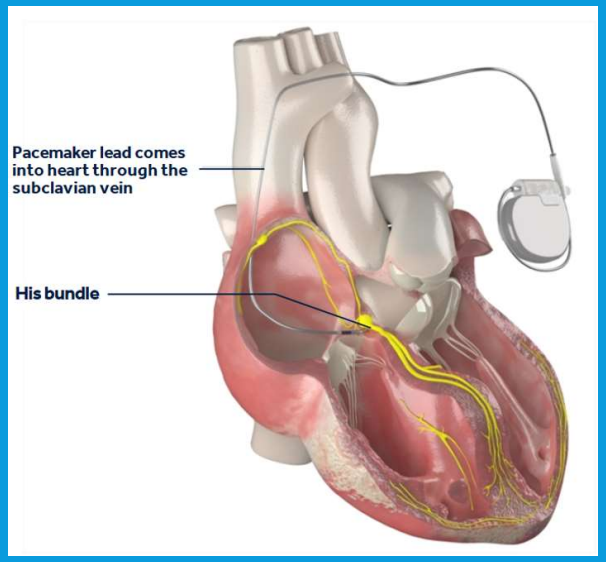


Cardiac Resynchronization System

CRT THERAPY

PHYSIOLOGIC PACING

At UVMMC we are also a leader in physiologic pacing
-tapping into the natural conduction system pathway.



Outcomes*

- Narrow Paced QRS[3-5, 11, 12]
- Improved and preserved LV function[3, 4, 12]
- Lower HF-related hospitalization in frequently paced (>40%) patients[3, 11, 12]
- Corrected LBBB in certain patients[14]
- Successfully paced AVB (both infra-nodal and intra-Hisian)[7]

*as compared to RV apical pacing

IMPLANTABLE LOOP RECORDERS

An implantable loop recorder is a type of heart monitoring device that continuously records your heart rhythm
for several years

- Implanted under the skin in the left parasternal region

- Used when symptoms occur infrequently or other heart monitoring tools don't detect abnormalities

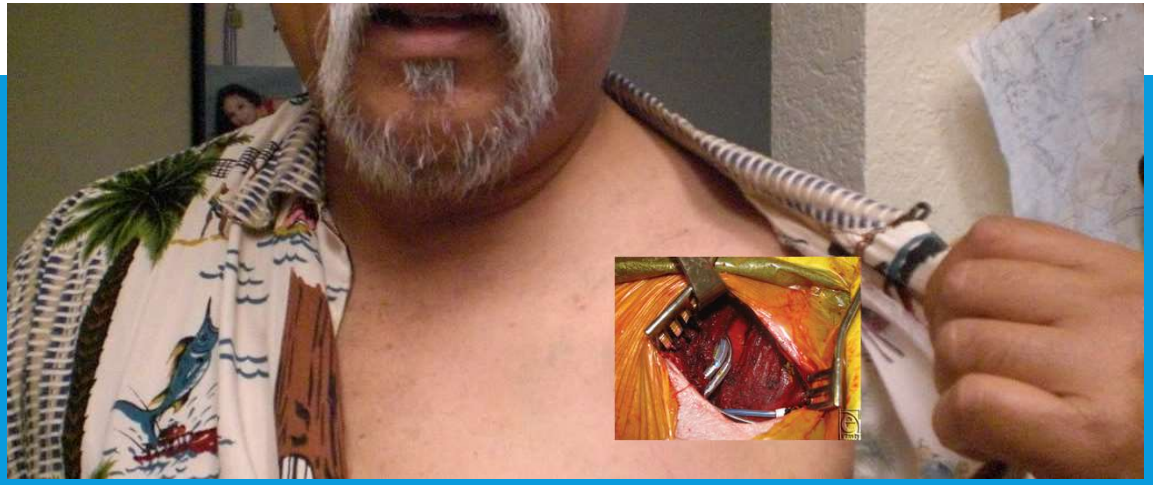
IMPLANTABLE LOOP RECORDERS

Reasons for ILR implant

- Syncope/LOC
  – Bradycardia or pauses?
- Palpitations
  – Brady or tachyarrythmias?
- VT Monitoring
- AF Monitoring Post Ablation
  – Was ablation successful?
  – Can we take patient off anticoagulation meds?
- Cryptogenic Stroke

IMPLANTABLE LOOP RECORDERS

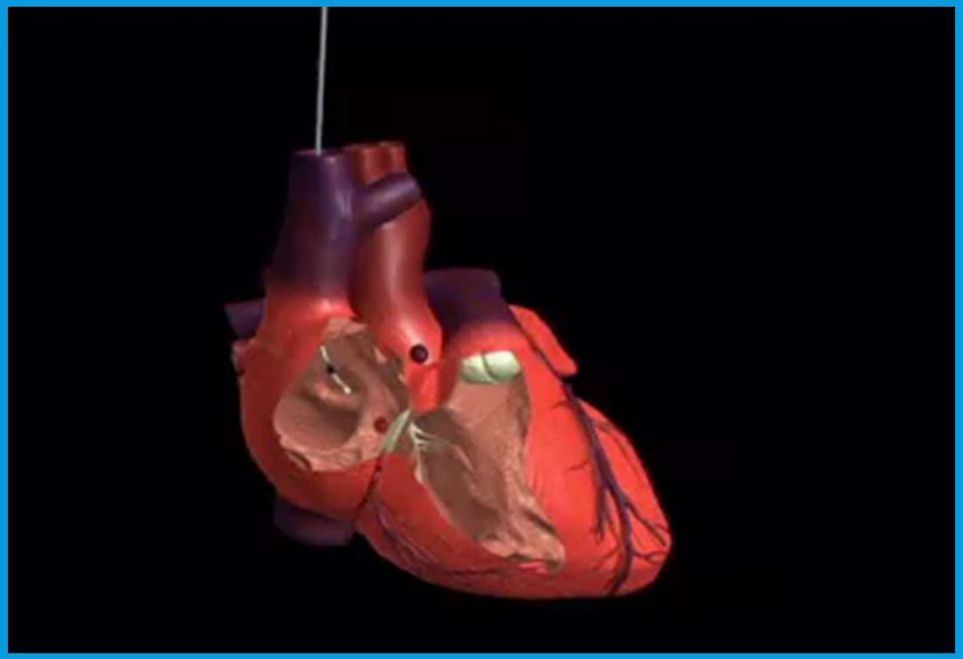
How are these devices Implanted?



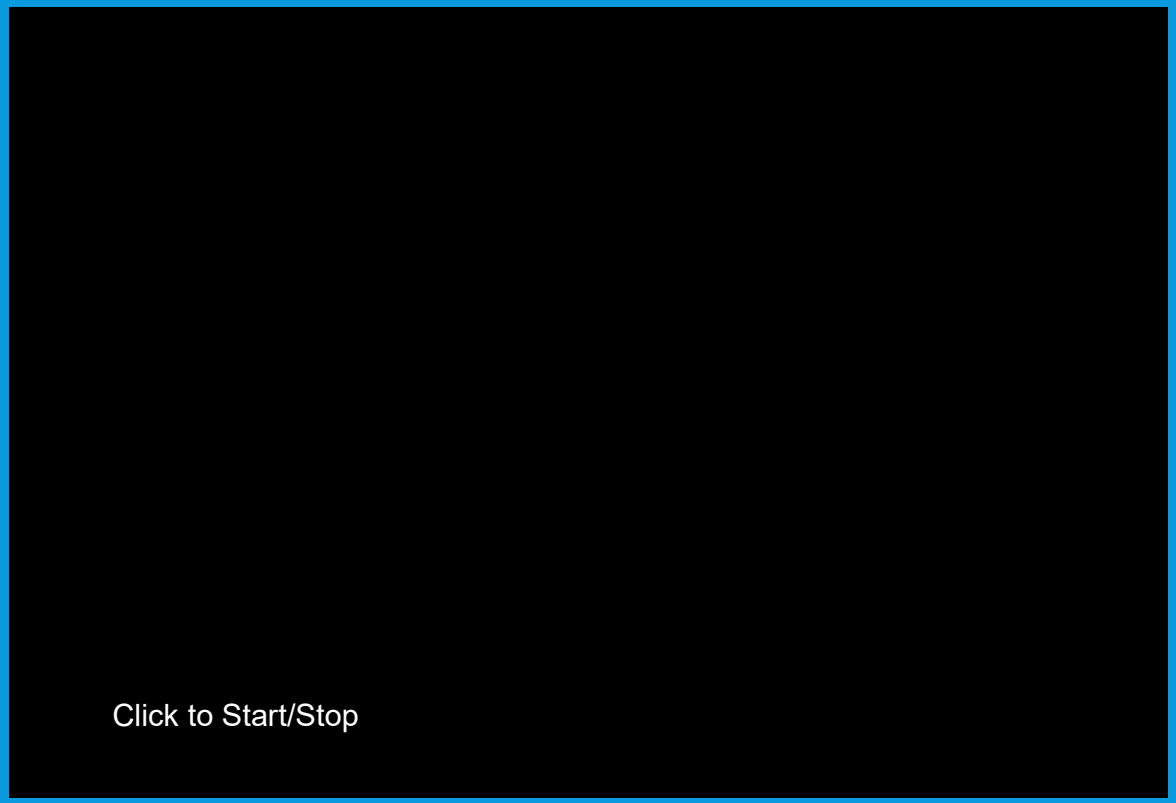
Small devices – Pectoral site

- Transvenous, single incision
- Local anesthesia; conscious sedation
- using Fluoroscopy
- Lead or leads are delivered into the heart using an introducer via the Subclavian Vein to SVC to RA, RV or on top of the LV via the Coronary sinus .

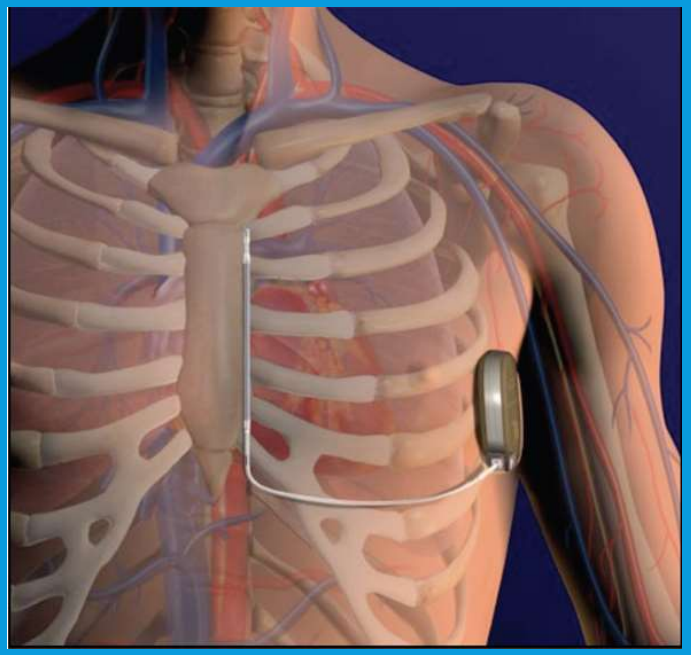
RIGHT VENTRICULAR LEAD PLACEMENT ACTIVE FIXATION LEAD



CRT DEVICE
CORONARY SINUS -LV LEAD PLACEMENT

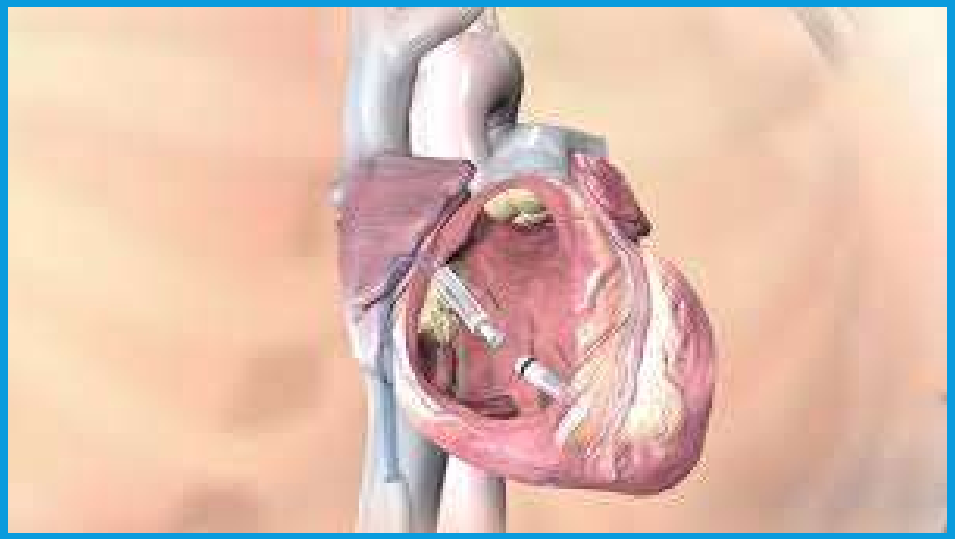


SUBCUTANEOUS ICD OR SICD



- Limited or No Fluoroscopy
- MAC or general anesthesia

LEADLESS PACEMAKERS



- Pacemaker is deployed directly in the right ventricle via the femoral vein > ICV

REMOTE MONITORING

https://www.youtube.com/watch?v=m_cRAntpZo8

DEVICE CLINIC WORKFLOW

- Remote monitoring workflow at UVMMC Device Clinic:
  - Patients are set up with a remote monitor within 2-4 weeks of PPM/ICD implant. On day of ILR implant patients will receive their monitor.
  - Follow up process with the remote monitor is discussed with the patient and/or family at the 3 month s/p implant check

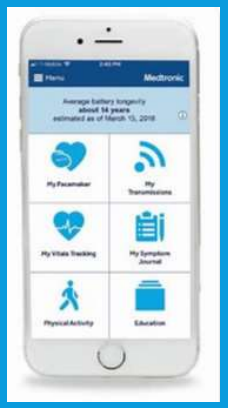
Type of Device	Frequency of follow up
ILR	1/ month
Pacemaker	Every 6 months
ICD	Every 3 months
Physiologic pacing	Every 3 months for first 2 years of implant

HOW/WHERE WE DO REMOTE MONITORING

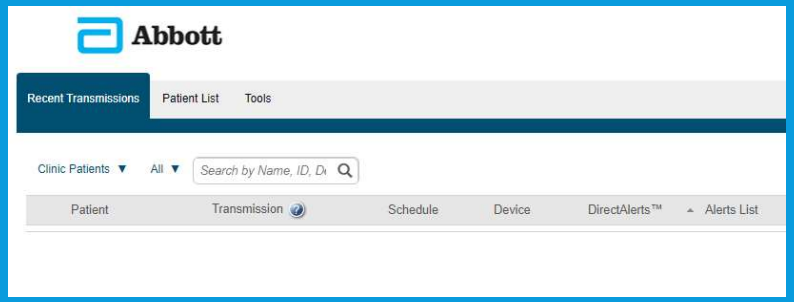
- Staff log into the remote sites Monday-Friday, 7:00am-4:30pm
- Throughout the day staff are routinely monitoring: scheduled reports, alerts, patient initiated transmissions, disconnected monitoring, missed reporting.

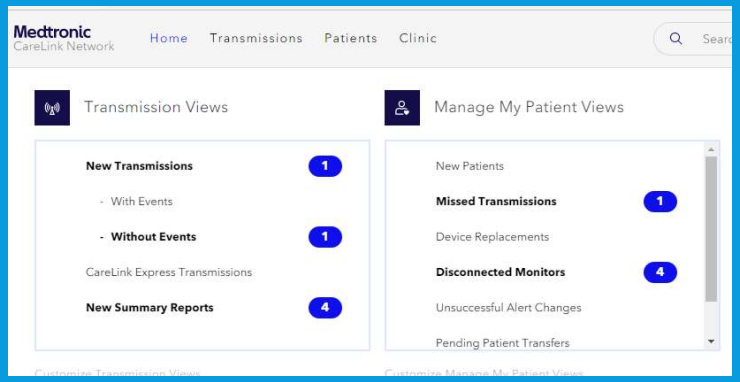
- Alert criteria for reporting
  - Defined critical values:
  - • New onset of AF/flutter
  - • AF with ventricular rate >100bpm for ≥ 3 hours
  - • SVT >170bpm
  - • NSVT for >10 consecutive beats
  - • Brady <30bpm
  - • Pause >3 seconds in NSR or ≥ 6 seconds in AF
  - • Battery at ERI
  - • Any tachy therapy from ICD
  - • Thoracic Impedance value above baseline
  - • Any value outside of manufacturer's programmed alerts
  - o Ex: lead impedances, device malfunction, etc.

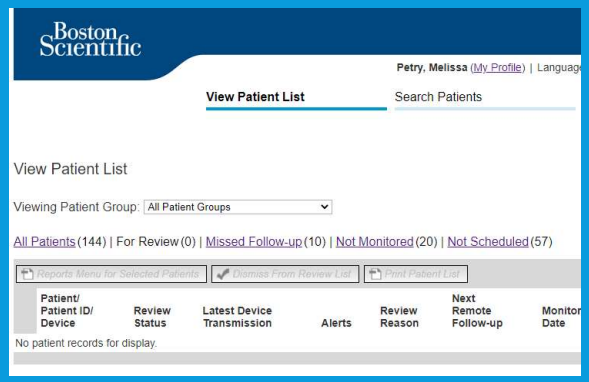
HOW/WHERE WE DO REMOTE MONITORING

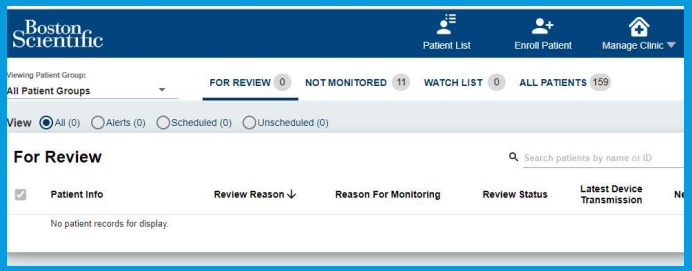


HOW/WHERE WE DO REMOTE MONITORING





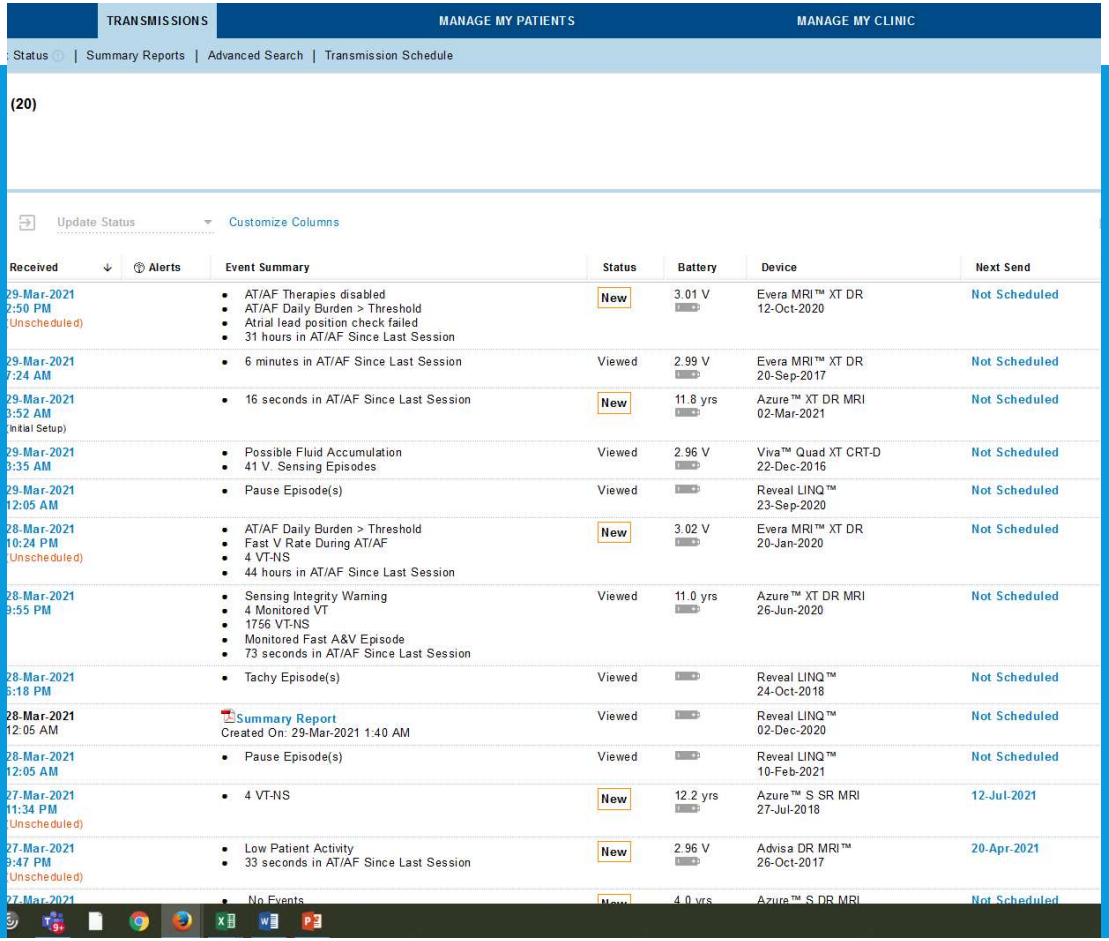




WHAT CAN BE MONITORED

- Device function
- Device integrity – lead integrity
- Rhythm diagnostics
- Heart failure diagnostic

WHAT CAN BE MONITORED



DEVICE INTEGRITY AND LEAD FUNCTION

Device Status (Implanted: 22-Dec-2016)

Remaining Longevity 2.9 years (29-Mar-2021)

(based on initial interrogation)

		Atrial(5076)	RV(6935M)	LV(4598)
Pacing Impedance	→	456 ohms	399 ohms	323 ohms
Defibrillation Impedance			RV=56 ohms	
Capture Threshold	→	1.375 V @ 0.40 ms	0.750 V @ 0.40 ms	1.000 V @ 0.40 ms
Measured On		29-Mar-2021	29-Mar-2021	29-Mar-2021
Programmed Amplitude/Pulse Width		2.00 V / 0.40 ms	2.00 V / 0.40 ms	1.50 V / 0.40 ms
Measured P/ R Wave	→	1.0 mV	7.4 mV	
Programmed Sensitivity		0.30 mV	0.30 mV	

Parameter Summary

Mode	DDDR	Lower Rate	60 bpm	AdaptivCRT	Adaptive Bi-V and LV
Mode Switch	171 bpm	Upper Track	130 bpm	V. Pacing	LV->RV
		Upper Sensor	120 bpm	Paced AV	160 ms
				Sensed AV	110 ms

Detection		Rates	Therapies
AT/AF	Monitor	>171 bpm	All Rx Off
VF	On	>188 bpm	ATP Before Charging, 35J x 6
FVT	OFF		All Rx Off
VT	OFF		All Rx Off

Enhancements On: VT Monitor, AF/Afl, Sinus Tach, Wavelet, TWave, Noise(Timeout)

OBSERVATIONS (2)

- Possible OptiVol fluid accumulation: 01-Mar-2021 -- ongoing.
- RV Capture Management: Actual safety margin (2.7 X) > programmed margin (2 X).

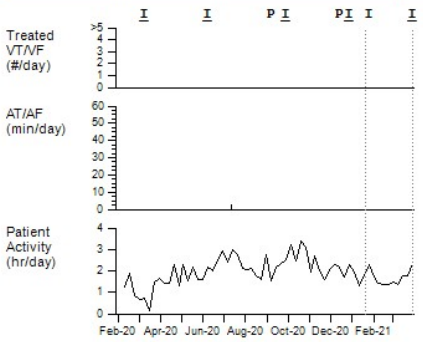
RHYTHM DIAGNOSTICS

Device: Viva™ Quad XT CRT-D DTBA1QQ Serial Number: BLC224943H Date of Interrogation: 29-Mar-2021 03:35:24

Clinical Status	Since 20-Jan-2021
Treated	
VF	0
FVT (Off)	
VT (Off)	
AT/AF(Monitor)	
Monitored	
VT (162-188 bpm)	0
VT-NS (>4 beats, >188 bpm)	0
High Rate-NS	0
SVT: VT/VF Rx Withheld	0
V. Oversensing-TWave Rx Withheld	0
V. Oversensing-Noise Rx Withheld	0
AT/AF	0
Time in AT/AF	0.0 hr/day (0.0%)

Functional	Last Week
Patient Activity	2.2 hr/day

Cardiac Compass Trends (Jan-2020 to Mar-2021)



Therapy Summary	VT/VF	AT/AF
Pace-Terminated Episodes	0	0
Shock-Terminated Episodes	0	0
Total Shocks	0	0
Aborted Charges	0	0

Pacing	(% of Time Since 20-Jan-2021)
Total VP*	96.5%
AS-VS	1.9%
AS-VP	79.9%
AP-VS	0.3%
AP-VP	17.9%

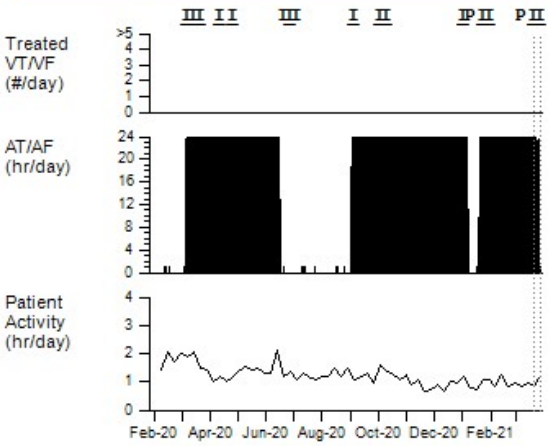
* Total VP may decrease 1% to 2% due to periodic AdaptivCRT sensing.

RHYTHM DIAGNOSTICS – AT/ AF

Device: Viva™ Quad XT CRT-D DTBA1QQ Serial Number: BLC205673H Date of Interrogation: 27-Mar-2021 00:0

Clinical Status	Since 20-Mar-2021
Treated	
VF	0
FVT (Off)	
VT (Off)	
AT/AF(Monitor)	
Monitored	
VT (150-188 bpm)	0
VT-NS (>4 beats, >188 bpm)	0
High Rate-NS	0
SVT: VT/VF Rx Withheld	0
V. Oversensing-TWave Rx Withheld	0
V. Oversensing-Noise Rx Withheld	0
AT/AF	360
Time in AT/AF	23.5 hr/day (98.1%)
Longest AT/AF	114 minutes
Functional	**Last Week**
Patient Activity	1.1 hr/day

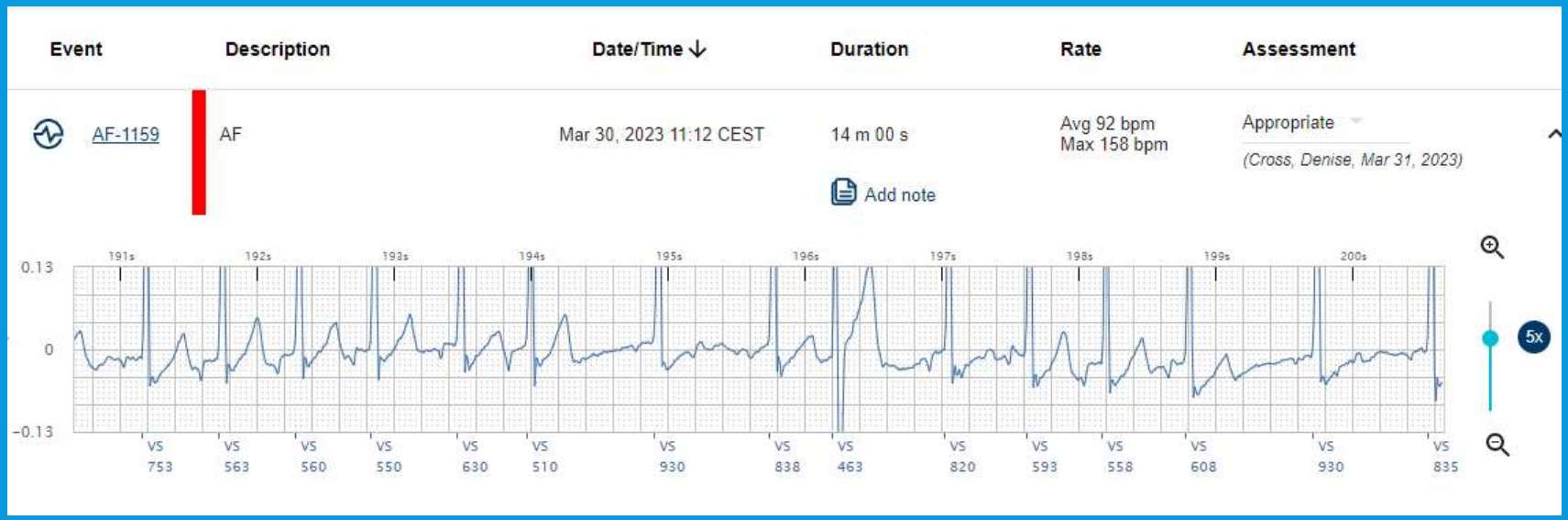
Cardiac Compass Trends (Jan-2020 to Mar-2021)



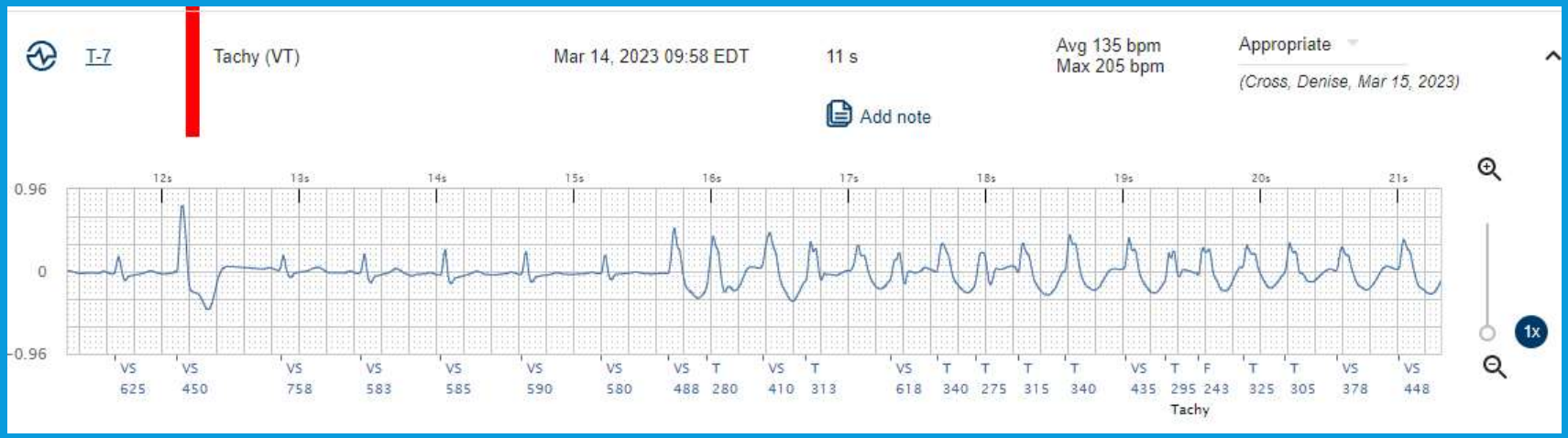
EGM - AT/AF


Device: Viva™ Quad XT CRT-D DTBA1QQ
Serial Number: BLC205673H
Date of Interrogation: 27-Mar-2021 00:00:07
EGM1: Atip to Aring
(0.1 mV)
EGM2: Can to RVcoil
(1 mV)
EGM3: RVtip to RVring
(1 mV)
LECG: RVcoil to Aring
(1 mV)
A-A Interval (ms)
Markers
V-V Interval (ms)

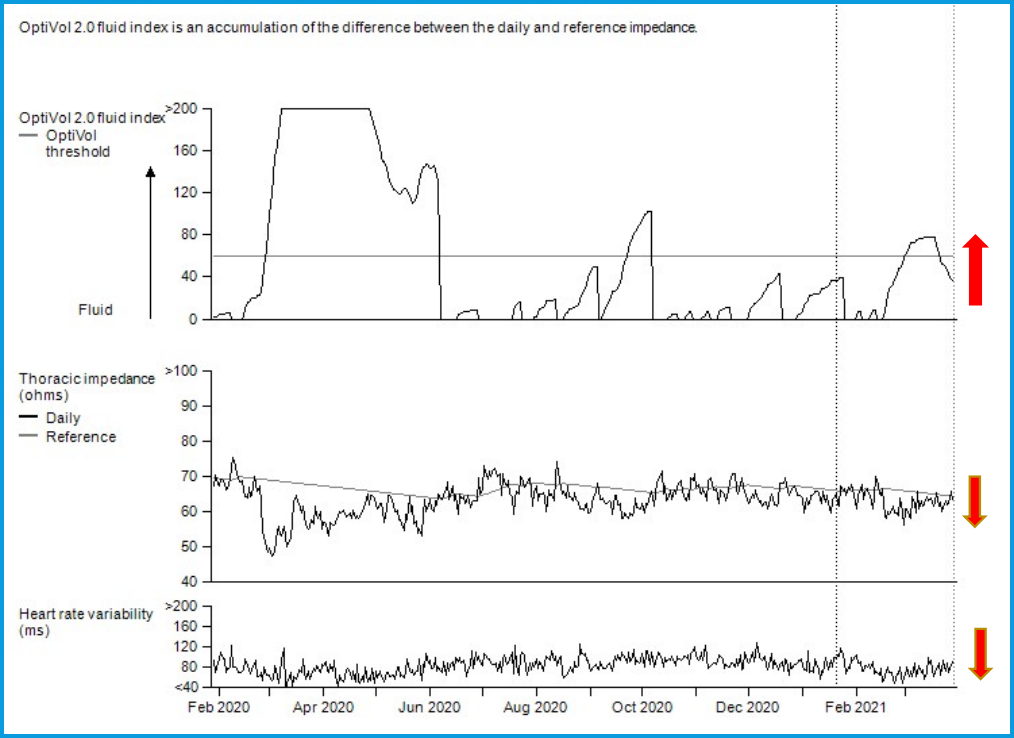
ILRS--


Event
Description
Date/Time
Duration
Rate
Assessment
AF-1159
AF
Mar 30, 2023 11:12 CEST
14 m 00 s
Add note
Avg 92 bpm
Max 158 bpm
Appropriate
(Cross, Denise, Mar 31, 2023)
191s
192s
193s
194s
195s
196s
197s
198s
199s
200s
0.13
0
-0.13
VS 753
VS 563
VS 560
VS 550
VS 630
VS 510
VS 930
VS 838
VS 463
VS 820
VS 593
VS 558
VS 608
VS 930
VS 835
5x

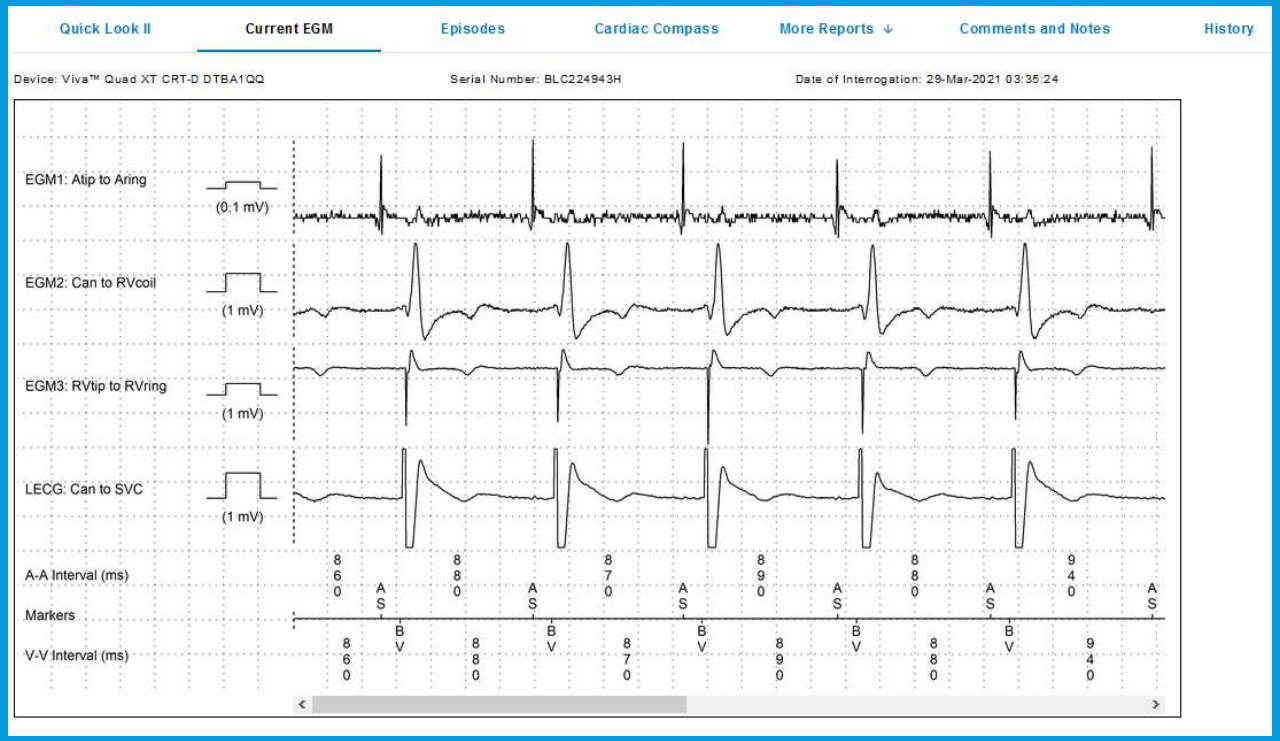
ILRS--VT


T-7
Tachy (VT)
Mar 14, 2023 09:58 EDT
11 s
Avg 135 bpm
Max 205 bpm
Appropriate
(Cross, Denise, Mar 15, 2023)
Add note
12s
13s
14s
15s
16s
17s
18s
19s
20s
21s
0.96
0
-0.96
VS 625
VS 450
VS 758
VS 583
VS 585
VS 590
VS 580
VS 488
T 280
VS 410
T 313
VS 618
T 340
T 275
T 315
T 340
VS 435
T 295
F 243
T 325
T 305
VS 378
VS 448
Tachy
1x

HEART FAILURE DIAGNOSTICS



CURRENT RHYTHM – EGM



ILRS--

Quick Look Data From: *23-Mar-2023 20:55 to 27-Mar-2023 11:21*

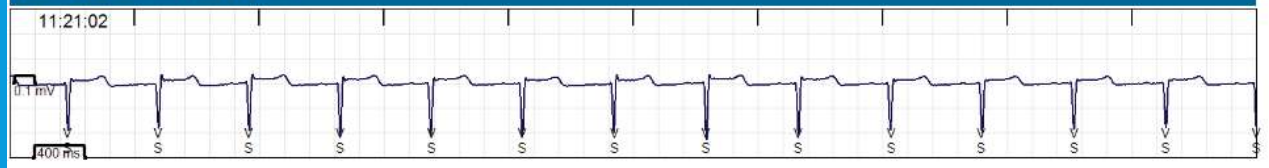
	Current	Lifetime	Parameters
Symptom	0	68	Four 7.5 min Episodes
Tachy	0	5	>162 bpm,>=16 beats
Pause	0	20	>3 seconds
Brady	0	0	<30 bpm,>=4 beats
AT	0	0	Off
AF	0	170	>=6 min
% of Time in AT/AF	0.0%	2.6%	

Observations

- No observations

ECG

Current ECG: *27-Mar-2023 11:21:02*



PROS AND CONS OF HOME MONITORING

- **Pros**
  - **Decreased in- person visits – COVID friendly**
    - Provides real time physiologic data – to assist with management of heart failure
    - Decreasing the need for in person visits - (case study Ahmed et al., 2020)
  - **Quicker recognition of device alerts – (afib, lead fracture, unsuccessfull tachy therapy etc)**
    - Landolina et al. (2012) showed significantly faster recognition/review of device alerts
    - 1.4 days remote group vs. 24.8 days for the standard arm (P< 0.001)
  - **Decreased ED visits/ urgent office visits for Heart Failure, arrhythmia, or ICD related events.**
    - 35% less frequent in the remote group over a 16 month period (75 remote vs. 117 standard; P= 0.005) - (Landolina et al.,2012)

PROS AND CONS OF HOME MONITORING

- **Pros**
  - **Increased access to care for those with limited mobility**
  - **Increased clinic efficiency by decreasing amount of time per follow-up**
    - Mean time spent on follow-up (Garcia-Fernandez et al., 2019)
      - Physicians - 5 minutes remote vs 10 minutes in office ($P < 0.0001$)
      - Nurse/tech 6 minutes remote vs. 13 minutes ($P = 0.002$)
  - **Improved quality of life scores (Landolina et al.,2012)**

PROS AND CONS OF HOME MONITORING

- Cons
  - Integration with EMR can be cluncky (Van der Velde, E. T., et al., 2013)
  - Alert fatigue – can be mitigated with proper programming of alerts (O'Shea, C. J., et al., 2021)
  - Connectivity – rural area – cell service- wifi –
  - Compliance - Patient resistance
  - Financial
  - Traveling (Pro as well)

SUMMARY

- CRM devices are implanted device that treat bradycardia, tachycardia and or heart failure
- Home monitor set up is relatively simply although may be confusing to the less tech savy
- CRM home monitor are used to monitor a variety of things including
  - Device system integrity
  - Arrhythmia episodes
  - Heart failure diagnostics
- Pros of using home monitoring
  - Quicker recognition of device alerts
  - Increased access to care for those with limited mobility
  - Better patient satisfaction
  - Decreased ED visits for Heart Failure
- Cons of home monitoring
  - Integration with EMR
  - Alert fatigue – proper programming of alerts
  - Connectivity – rural area – cell service- wifi –
  - Compliance - Patient resistance

REFERENCES

- Ahmed, F. Z., Crosbie, C., Kahn, M., & Motwani, M. (2020). Protecting the most vulnerable during COVID-19 and beyond: a case report on the remote management of heart failure patients with cardiac implantable electronic devices. *European heart journal. Case reports*, *4*(FI1), 1–6. https://doi-org.ezproxy.uvm.edu/10.1093/ehjcr/ytaa249
- Landolina, M., Perego, G. B., Lunati, M., Curnis, A., Guenzati, G., Vicentini, A., Parati, G., Borghi, G., Zanaboni, P., Valsecchi, S., & Marzegalli, M. (2012). Remote monitoring reduces healthcare use and improves quality of care in heart failure patients with implantable defibrillators: the evolution of management strategies of heart failure patients with implantable defibrillators (EVOLVO) study. *Circulation*, *125*(24), 2985–2992. https://doi-org.ezproxy.uvm.edu/10.1161/CIRCULATIONAHA.111.088971
- García-Fernández, F. J., Osca Asensi, J., Romero, R., Fernández Lozano, I., Larrazabal, J. M., Martínez Ferrer, J., Ortiz, R., Pombo, M., Tornés, F. J., & Moradi Kolbolandi, M. (2019). Safety and efficiency of a common and simplified protocol for pacemaker and defibrillator surveillance based on remote monitoring only: a long-term randomized trial (RM-ALONE). *European heart journal*, *40*(23), 1837–1846. https://doi-org.ezproxy.uvm.edu/10.1093/eurheartj/ehz067
- Van der Velde, E. T., Atsma, D. E., Foeken, H., Witteman, T. A., & Hoekstra, W. H. (2013). Remote monitoring of patients with implanted devices: data exchange and integration. *European journal of preventive cardiology*, *20*(2 Suppl), 8–12. https://doi-org.ezproxy.uvm.edu/10.1177/2047487313487483b
- O'Shea, C. J., Middeldorp, M. E., Hendriks, J. M., Brooks, A. G., Lau, D. H., Emami, M., Mishima, R., Thiyagarajah, A., Feigofsky, S., Gopinathannair, R., Varma, N., Campbell, K., & Sanders, P. (2021). Remote Monitoring Alert Burden: An Analysis of Transmission in >26,000 Patients. *JACC. Clinical electrophysiology*, *7*(2), 226–234. https://doi-org.ezproxy.uvm.edu/10.1016/j.jacep.2020.08.029
- Medtronic. His Bundle Pacing Clinical Evidence, Leads, and Catheters. www.MedtronicAcademy.com. Accessed 21 April 2023.

Life Before ICDs