

# Home telemetry for children with pacemakers and ICDs

## Benefits and limitations

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## Box 1 Indications for pacemaker implantation in childhood\*

Complete atrioventricular block following cardiac surgery

Symptomatic congenital complete heart block

Asymptomatic congenital complete heart block in association with:

- Low mean heart rate <50–55 bpm in neonates

- Nocturnal pauses

- Bradycardia related arrhythmias

Acquired heart block in myopathies

Symptomatic bradycardias in:

- Sick sinus syndromes

- Long QT syndromes

Reflex anoxic seizures with secondary anoxic epileptic seizures

\* For a comprehensive list of indications (including relative indications), the reader is referred to the AHA/NASPE/HRS 2008 guidelines.<sup>1</sup>

Education in Heart

CONGENITAL HEART DISEASE

### Cardiac pacing in infants and children

Karen A McLeod

## 15. Recommendations for Implantable Cardioverter-Defibrillators in Pediatric Patients and Patients With Congenital Heart Disease

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### CLASS I

1. ICD implantation is indicated in the survivor of cardiac arrest after evaluation to define the cause of the event and to exclude any reversible causes. (*Level of Evidence: B*) (149–152)
2. ICD implantation is indicated for patients with symptomatic sustained VT in association with congenital heart disease who have undergone hemodynamic and electrophysiological evaluation. Catheter ablation or surgical repair may offer possible alternatives in carefully selected patients. (*Level of Evidence: C*) (153)

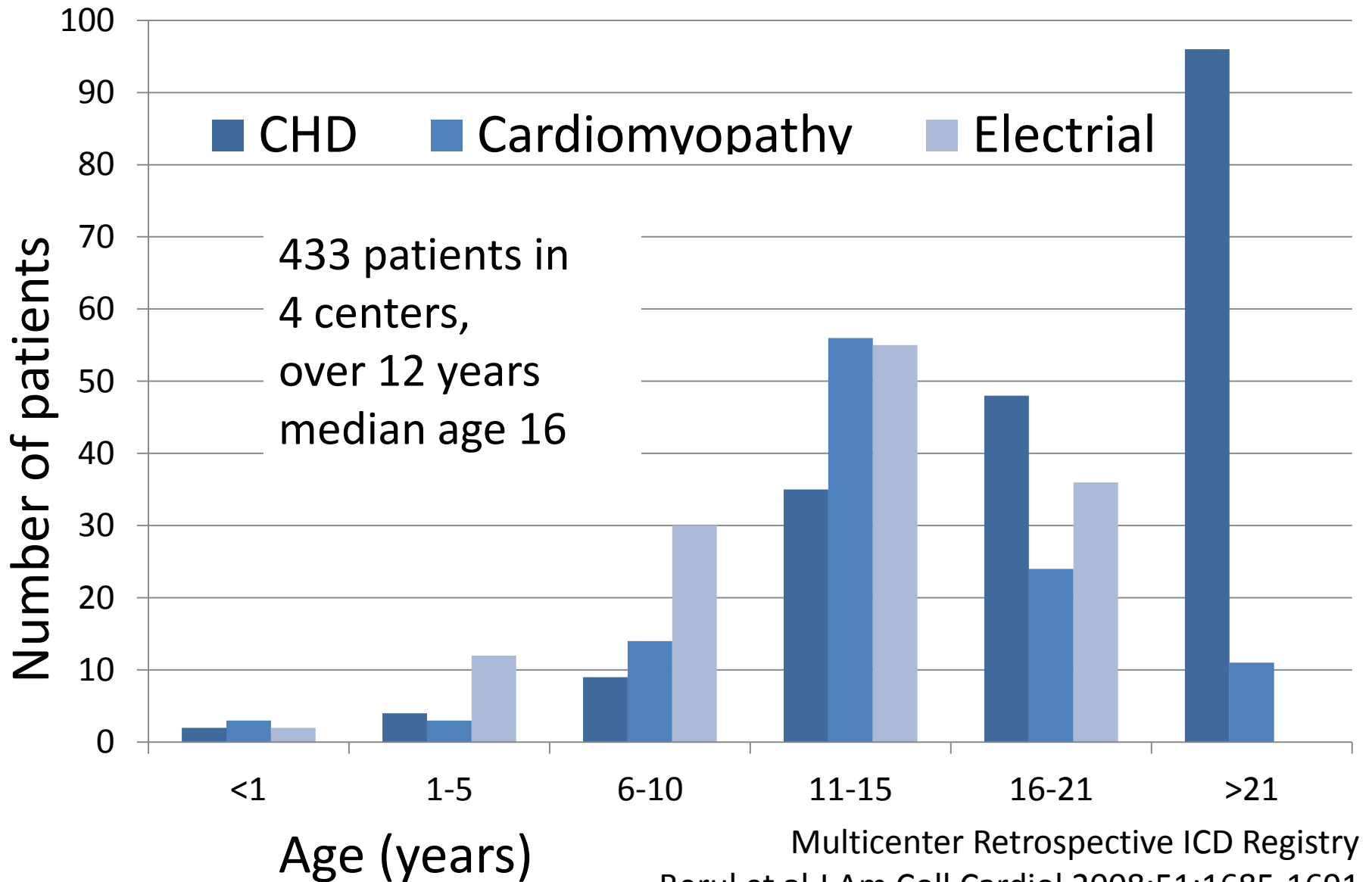
# 15. Recommendations for Implantable Cardioverter-Defibrillators in Pediatric Patients and Patients With Congenital Heart Disease

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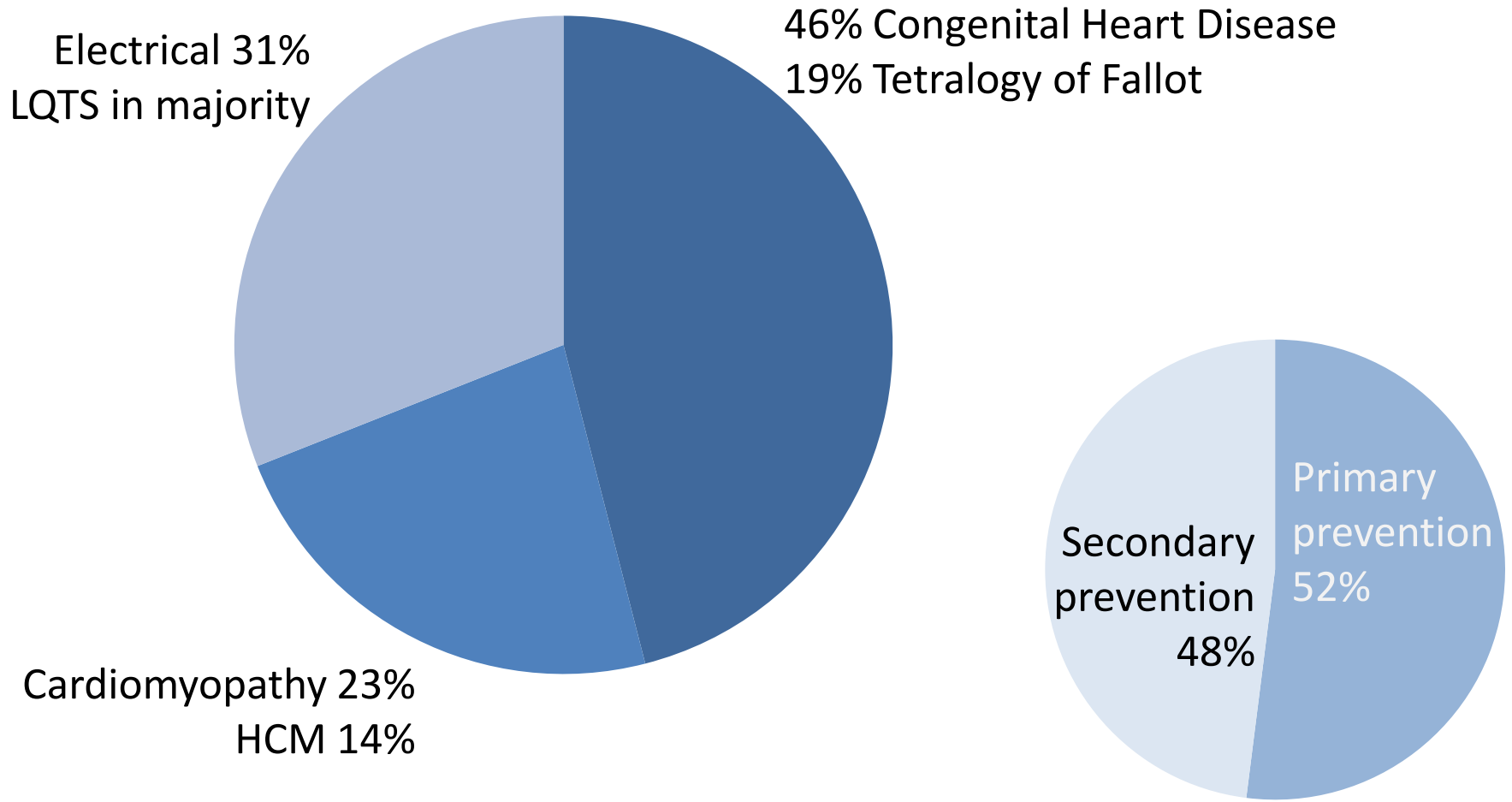
## **CLASS IIa**

1. ICD implantation is reasonable for patients with congenital heart disease with recurrent syncope of undetermined origin in the presence of either ventricular dysfunction or inducible ventricular arrhythmias at electrophysiological study. (*Level of Evidence: B*)  
(6,154)

# Reasons for ICD implantation in children and those with Congenital Heart disease



# Reasons for ICD implantation in children and those with Congenital Heart disease



# Problems with ICD implantation in children and those with Congenital Heart disease

## Inappropriate Shocks

- Occurred in 21%, mean number of shocks 4
- Attributed to
  - lead failure in 14%
  - Sinus or atrial tachycardias in 9%
  - And/or oversensing in 4%

# Problems with ICD implantation in children and those with Congenital Heart disease

## Complications

- 64 acute complications in 55 patients during the first 30 days (12.5%)
- Chronic or late complications in 26%
  - Lead related problems in the majority
  - Electrical storm
  - Inappropriate shocks not related to lead failure



# CLINICAL GUIDANCE BY CONSENSUS FOR THE FOLLOW UP OF IMPLANTABLE CARDIAC DEVICES FOR CARDIAC RHYTHM MANAGEMENT, October 2008



## **Suggested appointments schedule [ for pacemakers]**

Yearly for pacemakers implanted for less than 7-10 years depending on the manufacturers recommendation and expected battery longevity.

6 monthly for implants exceeding 7-10 years until ERI is reached.

3-6 monthly for Devices that exceed the manufacturers suggested longevity or show decline in battery life.

At Cardiac Physiologists discretion for devices that require closer monitoring e.g. programming/lead issues.

## **No appointments schedule suggested for ICDs**

<http://www.hruk.org.uk/Docs/Guidelines/HRUK%20Standards%20for%20Implantation%20and%20Follow-up%20of%20Cardiac%20Rhythm%20Management%20Devices%20-%20February%202011%20FINAL.pdf>

Frequency of pacemaker/ICD follow up  
**in person** or by remote monitoring

- **Within 72 hours of implantation**
- **2-12 weeks post implantation**
- Every 3 - 12 months (pacemaker)
- Every 3 - 6 months (ICD)
- **Annually until battery depletion**
- 1 - 3 months at signs of battery depletion

# Remote monitoring

The patient with a pacemaker or ICD capable of remote monitoring must agree to his data being transmitted to a secure server, in or outside Europe

He is then supplied with a transmitter, which should be connected to an analogue phone line

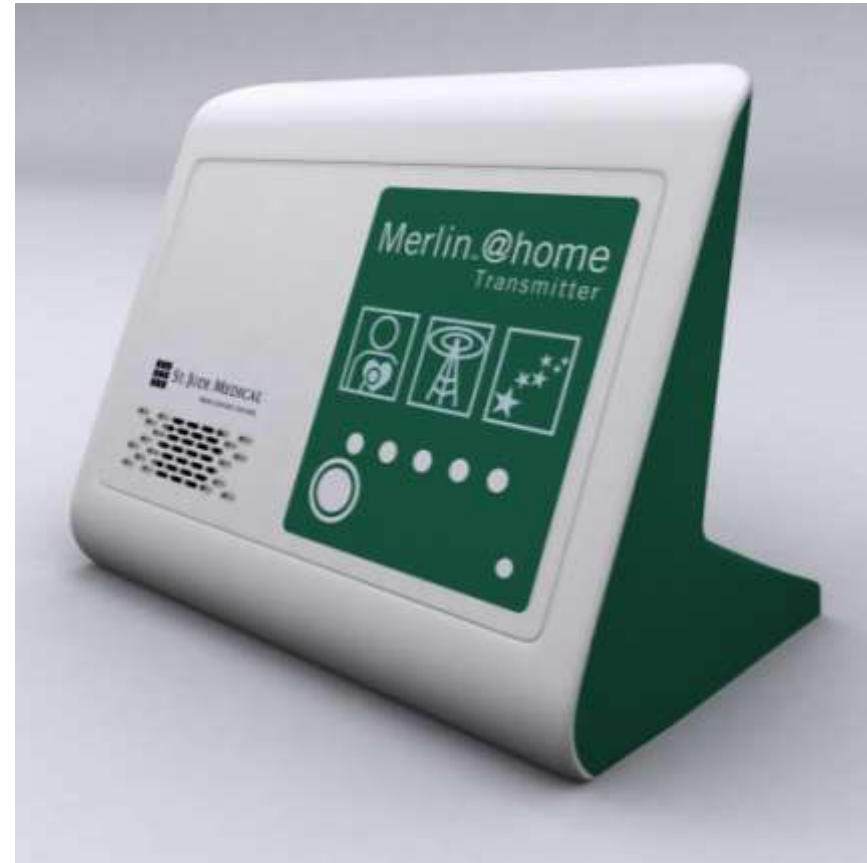
Data transmission from the device to the transmitter may either be via a telemetry wand, or by radiofrequency

If by radiofrequency, it may either be automatic, or patient initiated



Biotronik  
Cardiomessenger  
GSM; mobile

SJM Merlin@home  
Analogue phone line;  
fixed



# Remote monitoring

Automatic monitoring using radiofrequency allows transmission of prespecified alerts on a daily basis, related to device parameters, arrhythmias and clinical status, in addition to routine “follow up” transmissions

**Table 2 Comparison of different remote monitoring systems**

	<b>Biotronik Home Monitoring™</b>	<b>Medtronic CareLink™</b>	<b>Boston Scientific Latitude™</b>	<b>St Jude Merit™</b>
Wireless communication with implanted device	Radiofrequency	Radiofrequency	Radiofrequency	Radiofrequency
Data transmission	GSM network	Analogue phoneline	Analogue phoneline	Analogue phoneline
Transmitter	Mobile	Stationary	Stationary	Stationary
Frequency of transmissions	Daily FU; Alert events	Scheduled FU; Alert events	Scheduled FU; Alert events	Scheduled FU; Alert events
Remote follow-up	Yes	Yes	Yes	Yes
Remote monitoring	Yes	Yes	Yes	Yes
Physician notification	SMS, e-mail, fax	SMS, e-mail	Fax, phone	Fax, e-mail, SMS
Feedback to patient via transmitter	LED indicating normal status or call to clinic	LED indicating normal status or call to clinic	Automatic text and audio messages	LED indicating normal status or call to clinic
IEGM (real-time at remote follow-up)	30 s (monthly periodic EGMs)	10 s	10 s	30 s
IEGM (arrhythmic episodes)	All memorized episodes	All memorized episodes	All memorized episodes	All memorized episodes
Special features	Alerts fully configurable online	Automatic RA, RV and LV (only Consulta) pacing thresholds	Optional wireless weight scales and BP cuffs	Alerts fully configurable online
	Automatic RV and LV thresholds (only Lumax 500/540)	Optivol® lung fluid status alert	Configurable data transmission to associated caregivers	Possibility of sending data to phone calls
	Wireless PMs	Configurable red and yellow alerts	Configurable red and yellow alerts	Automatic RA, RV and LV thresholds (only ICDs)
			Electronic health record	

# Remote monitoring: benefits

Reduced hospital visits, saving

- patient time
- Relatives time
- Staff time (but investment needed to save)
- Transport costs

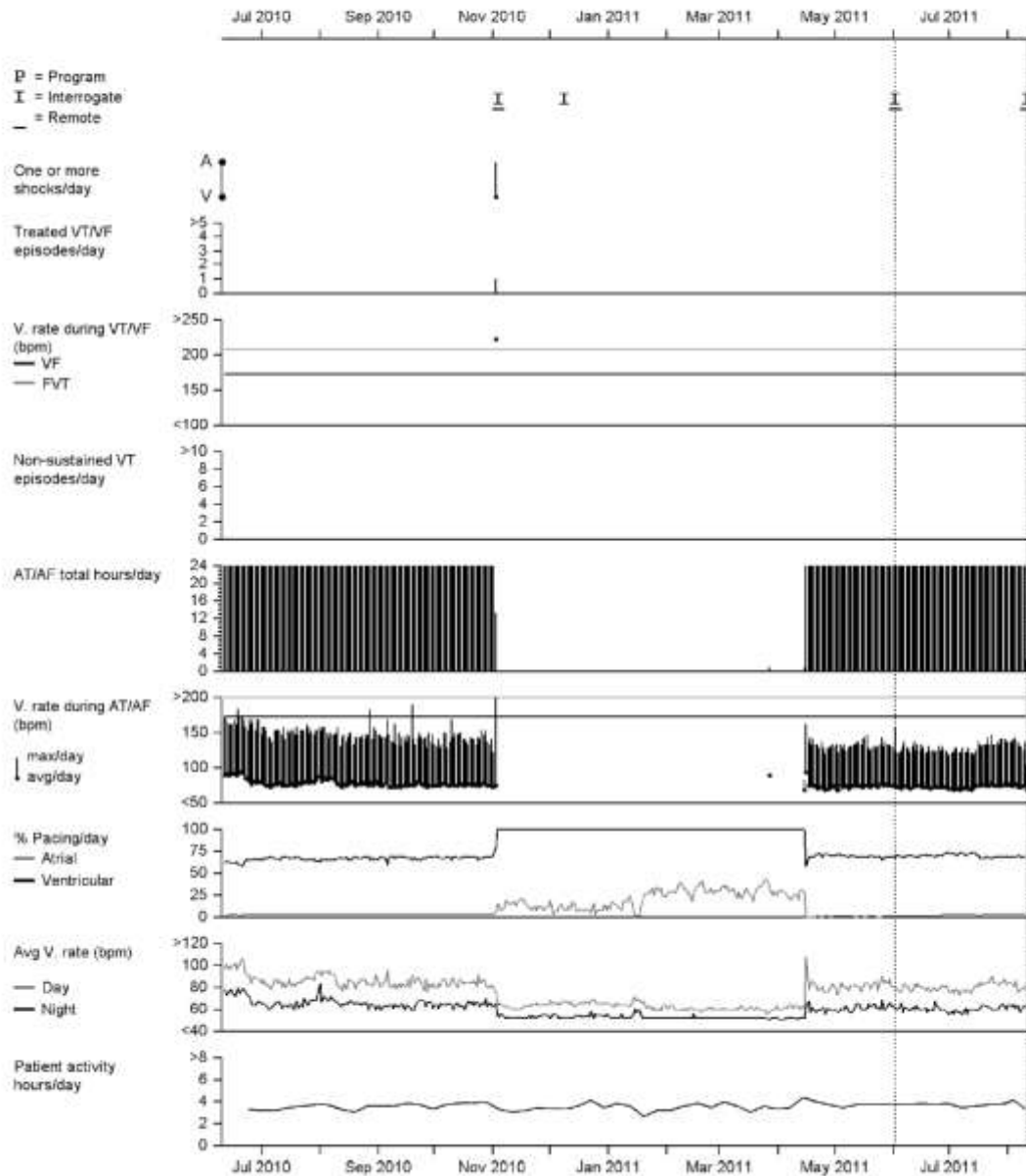
Earlier time to intervention for problems

- Lead failure
- Atrial fibrillation
- Heart failure monitoring
- Loss of biventricular pacing

Serial Number: **PYZ610704S**

 Date of Interrogation: **11-Aug-2011 02:26:05**

 ID: **0278571Q**

 Physician: **Dr J.M.McComb 0191 2336161**




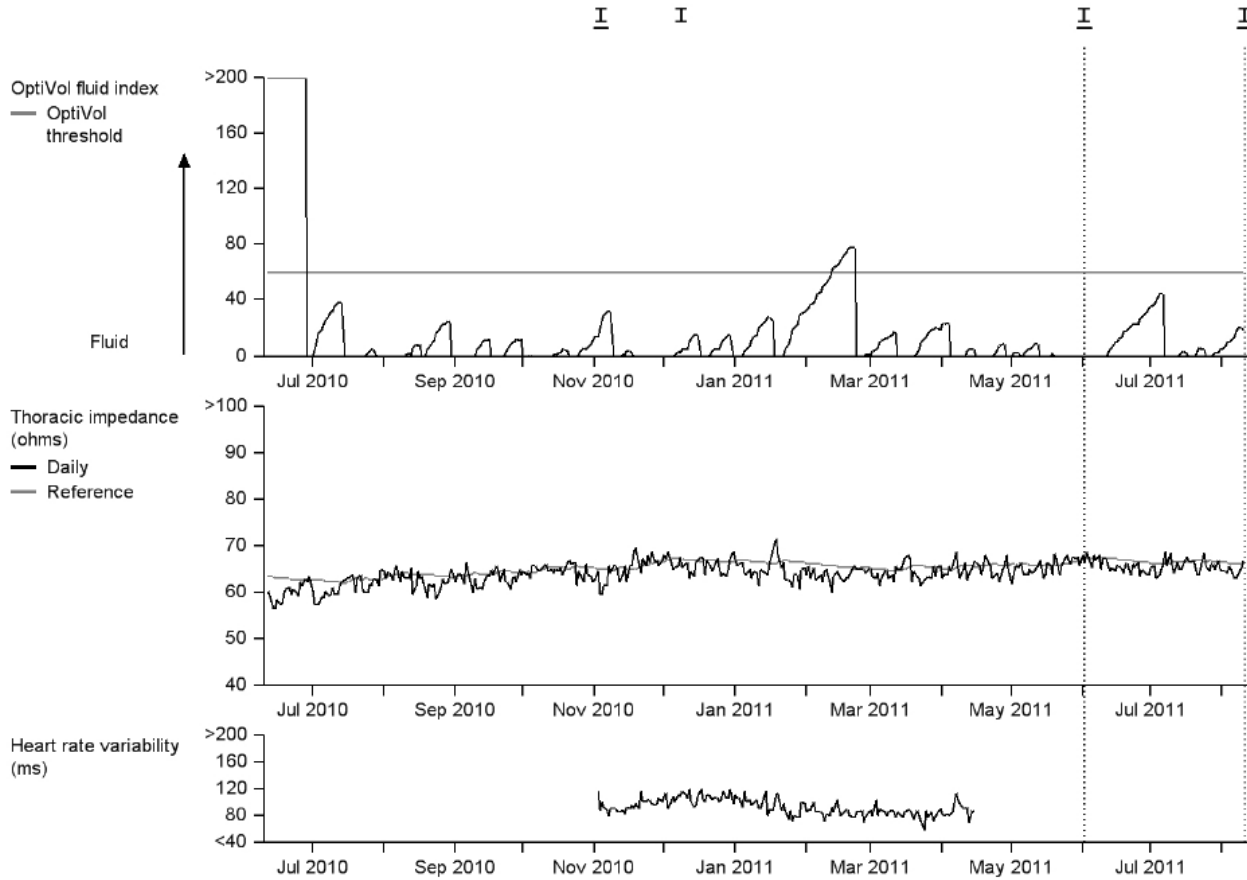
Serial Number: PYZ610704S

Date of Interrogation: 11-Aug-2011 02:26:05

ID: 0278571Q

Physician: Dr J.M.Mccomb 0191 2336161

OptiVol fluid index is an accumulation of the difference between the daily and reference impedance.



# Remote monitoring: problems

## Technical problems

- Most require analogue phone line in the bedroom
- Interference with internet/cable TV etc “-it interferes with my wife’s internet shopping”
- “It doesn’t match the décor of the bedroom”
- It only works when the implanted device is close to the transmitter – most are fixed
- Some patients just don’t want it
- Extra staff time is required, at least at the beginning

# Remote monitoring: potential problems for children with PACEMAKERS

Annual follow up is recommended for pacemakers, at least until the battery voltage starts to fall

The majority of children with pacemakers have associated structural heart disease, and require clinical follow up – so there is no time saving (provided pacemaker clinic follow up can be coordinated with cardiac clinic)

## SIZE MATTERS

The smallest pacemaker generator available is the Microny (St Jude Medical, California, USA),

Microny SR

Weight 12.5g

Volume 5.9cc

Thickness 6mm



Accent DR RF

Weight 18g

Volume 9.5cc

Thickness 6mm

44% bigger, 38% heavier



# Remote monitoring: potential problems for children with PACEMAKERS & ICDs

Usually an analogue phone line in the bedroom is required, with the patient in his bed at night

The majority of remote PACEMAKER follow up in the UK is wanded

Automatic wireless follow up is preferred

GF ♂ dob 28/03/2005

Presented at birth with QT prolongation &  
2:1 AV block

Twin also has QT prolongation

Genotyping negative

2008 treated with nadalol

GF ♂ dob 28/03/2005

ECG 27/06/2006

HR 121bpm; QT 348ms; QTc 494ms



GF ♂ dob 28/03/2005

## atypical Timothy syndrome

- Abnormality of the CACNA1C gene, encoding for the calcium channel  $Ca_v1.2$
- QT prolongation (mean 600ms) → functional AV block (in utero or neonatal 2:1 AV block)
- VT or VF in 80%
- Congenital heart disease in 55%
- Hypertrophic cardiomyopathy in 30%

GF ♂ dob 28/03/2005

## atypical Timothy syndrome

- (Syndactyly)
- Facial dysmorphism in 90%
- Predisposition to sepsis in 50%
- Metabolic (hypoglycaemia) and immunological disturbance in 50%
- Neuropsychiatric involvement in 85%

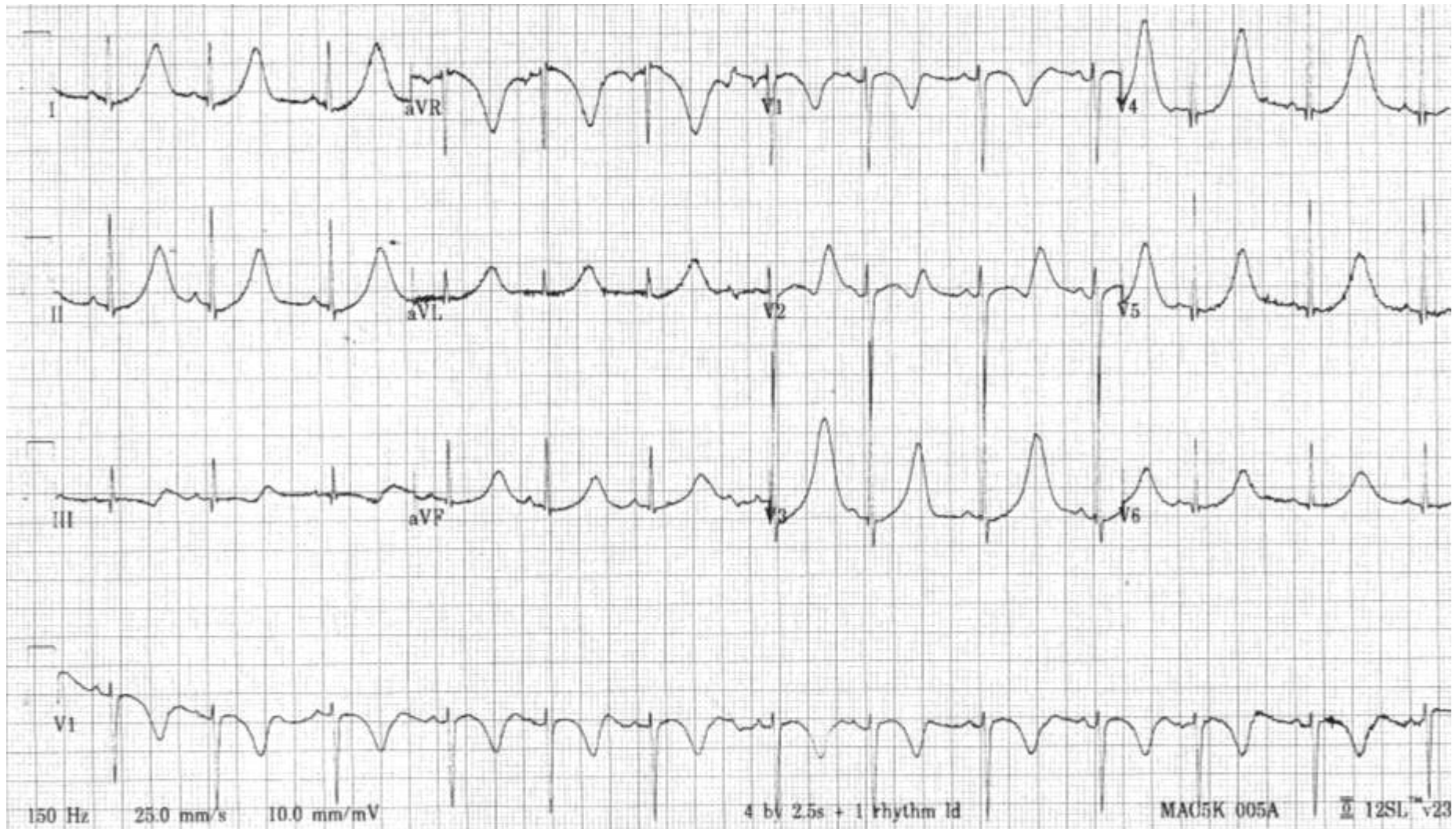
GF ♂ dob 28/03/2005

Syncopal attack 02/2010

GF ♂ dob 28/03/2005

ECG 2010

HR 77bpm; QT 534ms; QTc 604ms



GF ♂ dob 28/03/2005

### FVT Episode #21

Device: REVEAL DX 9528

Serial Number: RAB623843S

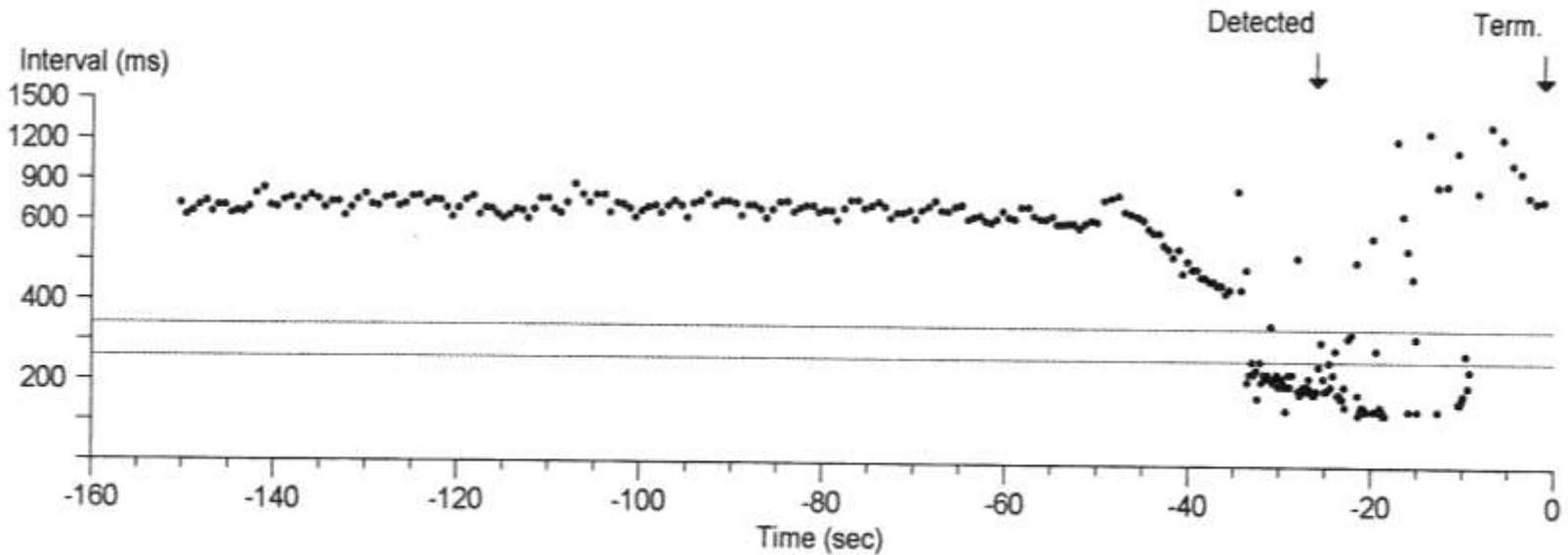
Date of Visit: 08-Jun-2010 09:54:39

ID: 0701707Y

Physician: Dr Wren 01912336161

ID#	Type	Date	Time hh:mm	Duration hh:mm:ss	Max V. Rate	Median V. Rate
21	FVT	08-Jun-2010	07:12	:24	429 bpm (140 ms)	316 bpm (190 ms)

FVT = 260 ms VT = 340 ms



GF ♂ dob 28/03/2005

Syncopal attack 02/2010

Loop recorder implanted

GF ♂ dob 28/03/2005



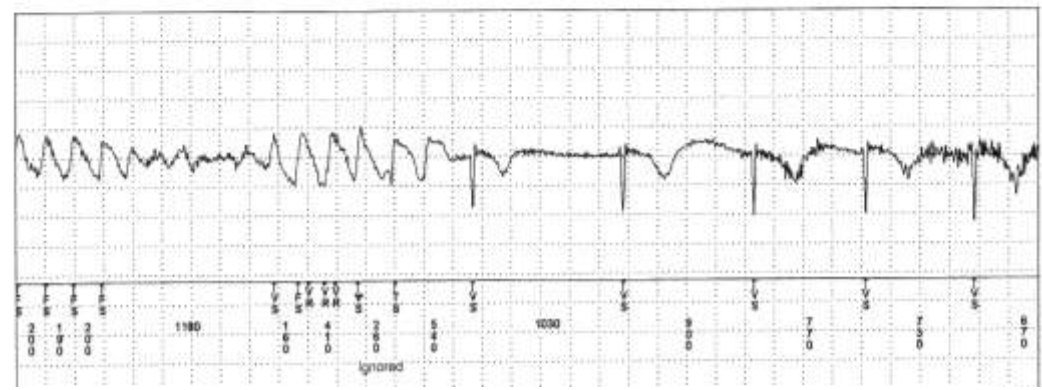
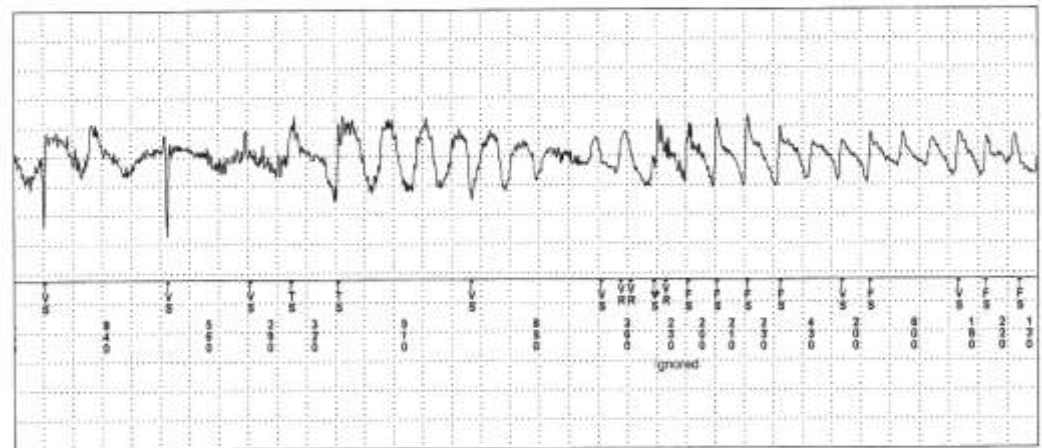
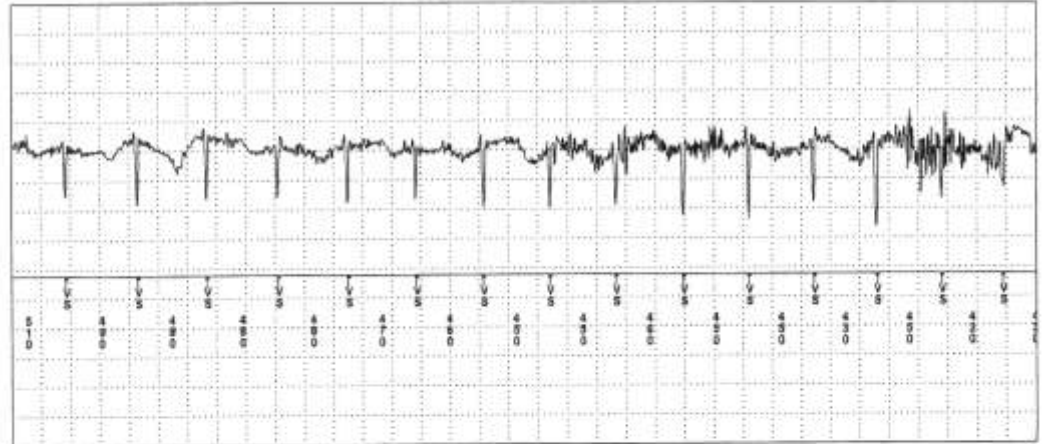
**SYMPTOM Episode #20**

Serial Number: RAB623843S

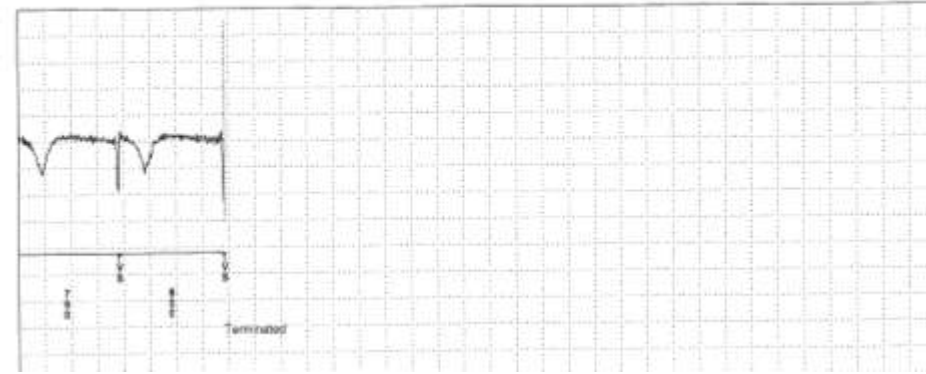
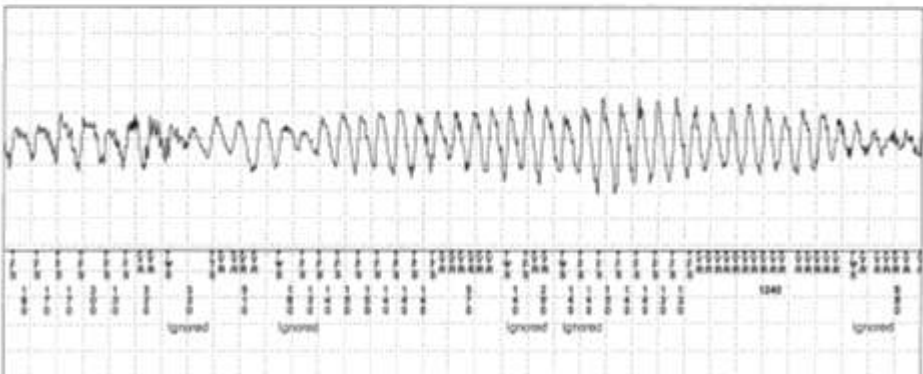
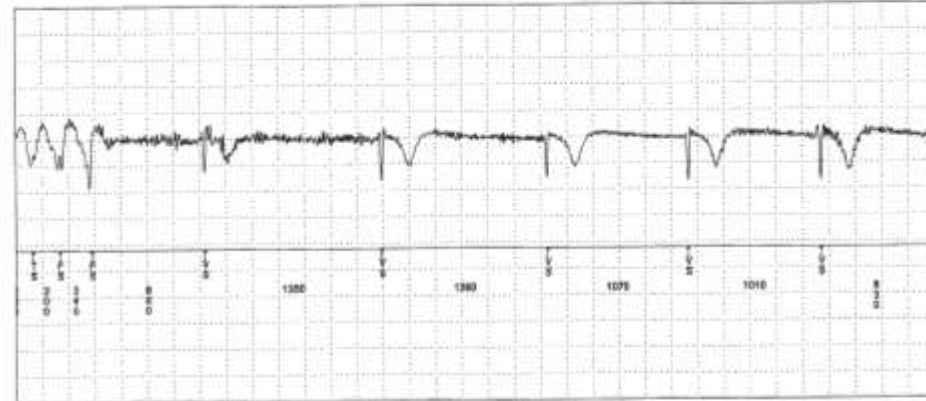
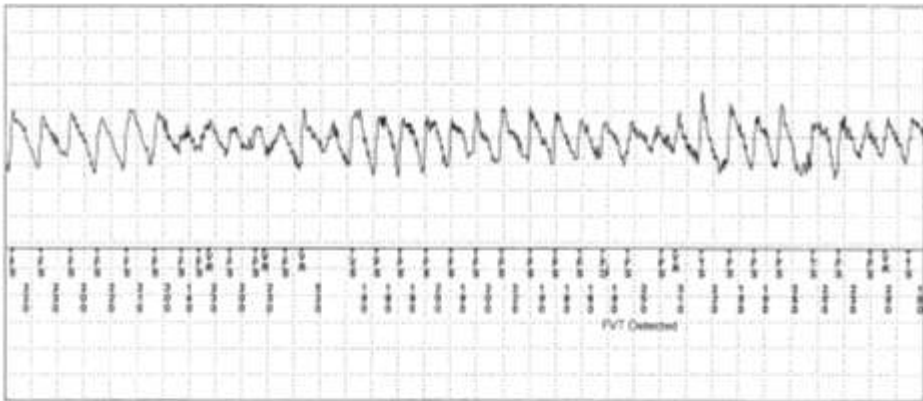
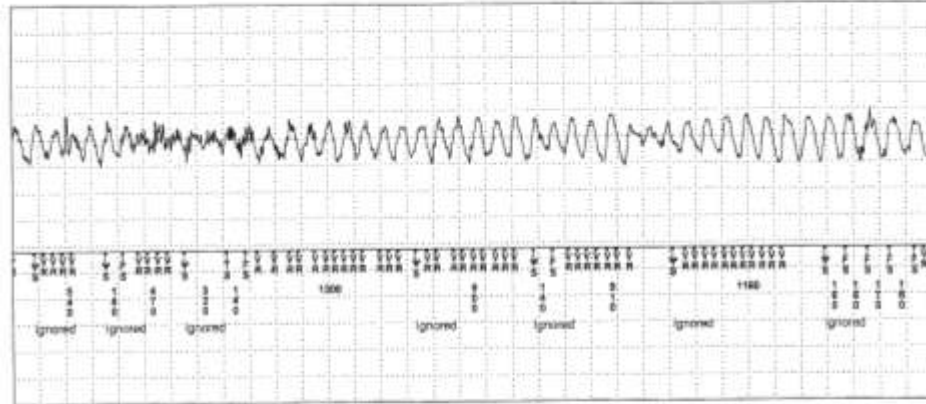
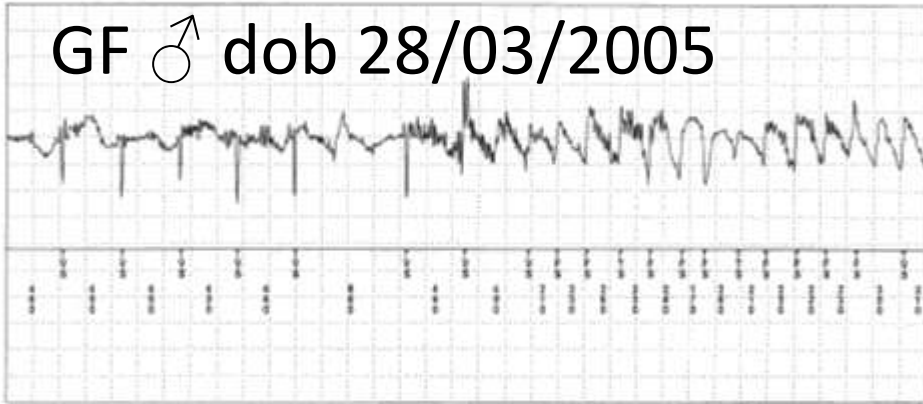
Date of Visit: 08-Jun-2010 09:54:39

ID: 0701707Y

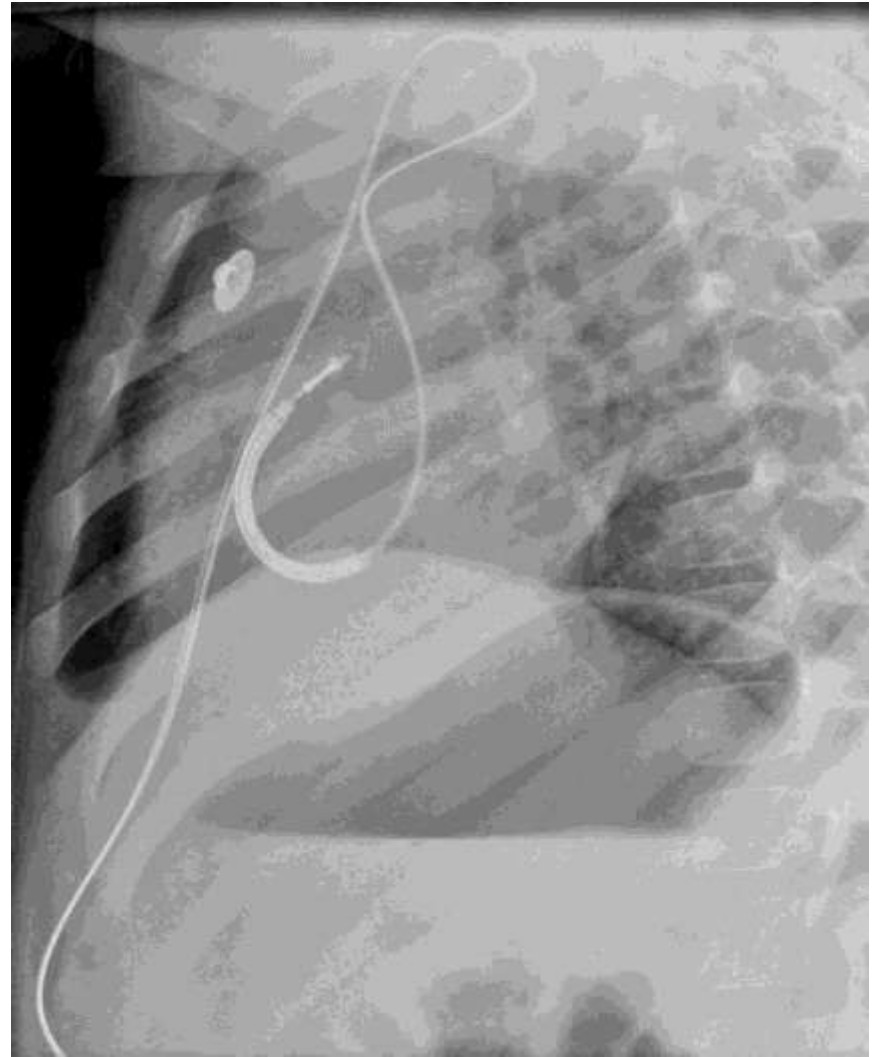
Episode #20 Chart speed: 25.0 mm/sec



GF ♂ dob 28/03/2005



GF ♂ dob 28/03/2005



## Patient's Home

Boston  
Scientific  
Device



LATITUDE  
Communicator



## LATITUDE Web Server



LATITUDE  
Weight Scale



LATITUDE  
BP Monitor



Optional components  
Available for an additional fee



Health  
Following  
Physician  
& RN



Device  
Managing  
Physician &  
RN



Date of Birth 28 Mar 2005  
 Device TELIGEN 100 F103/000394  
 Tachy Mode Monitor + Therapy

Latest Send 10 Jun 2011  
 Last Office Interrogation 26 Oct 2010  
 Implant Date 17 Jun 2010

**Event V-12 27 Jul 2010 07:05**

**VF Event Onset**

Avg V Rate 235 min<sup>-1</sup>  
 Detection Rate Only

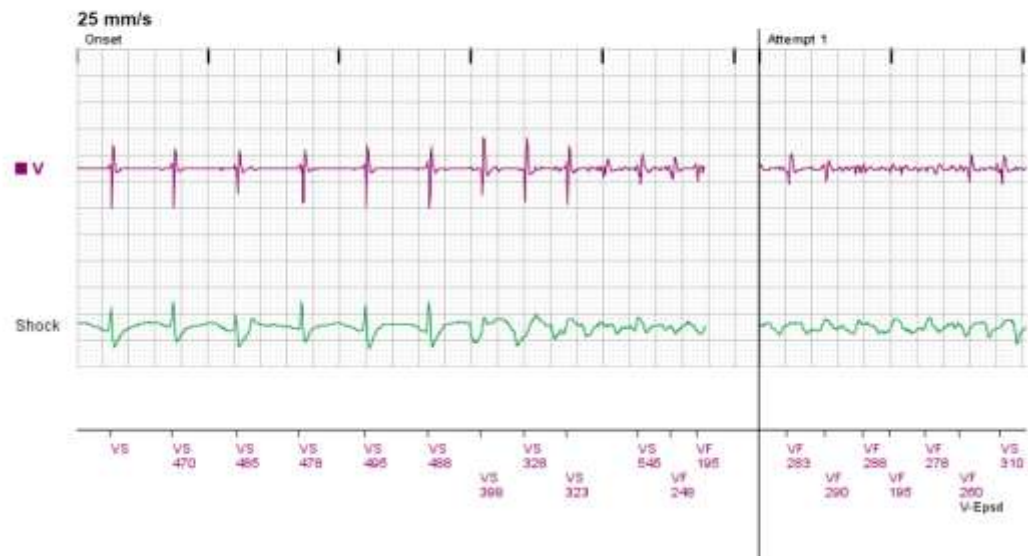
**Detection**

Avg V Rate 291 min<sup>-1</sup>  
 Rate Zone VF  
 RhythmID Correlated False  
 SRD Met (False, Off)  
 ATP Timeout False

**Attempt 1, 17J V Shock**

Elapsed Time 00:00:16  
**Shock Information**  
 Charge Time 2.9 s  
 Lead Impedance 44 Ω  
 Lead Polarity Initial

Event Ended 00:00:53





25 mm/s



VF	VS	VS	VF	VS	VS	VF	VF	VS	VF	VF	VF	VF	VF	VF	VF	VF	VF
145	310	323	248	308	488	230	255	413	220	185	228	175	180	138	145	288	148
VF			VF	VF		VF		VF	VF	VF	VF	VF	VF	VF		VF	
230			283	228		248	245	200	213	183	208	185	138	153		290	



VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF		
165	270	158	143	265	255	278	206	148	138	140	158	145	208	150	145	145	195	153	
VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	VF	
263	248	163	263	140	258	140	258	138	140	138	165	140		273	148	155	150	178	148



Patient ID [Redacted]  
 Date of Birth 28 Mar 2005  
 Device TELIGEN 100 F103/000394  
 Tachy Mode Monitor + Therapy

Latest Send 21 Jul 2010  
 Last Office Interrogation 18 Jun 2010  
 Implant Date 17 Jun 2010

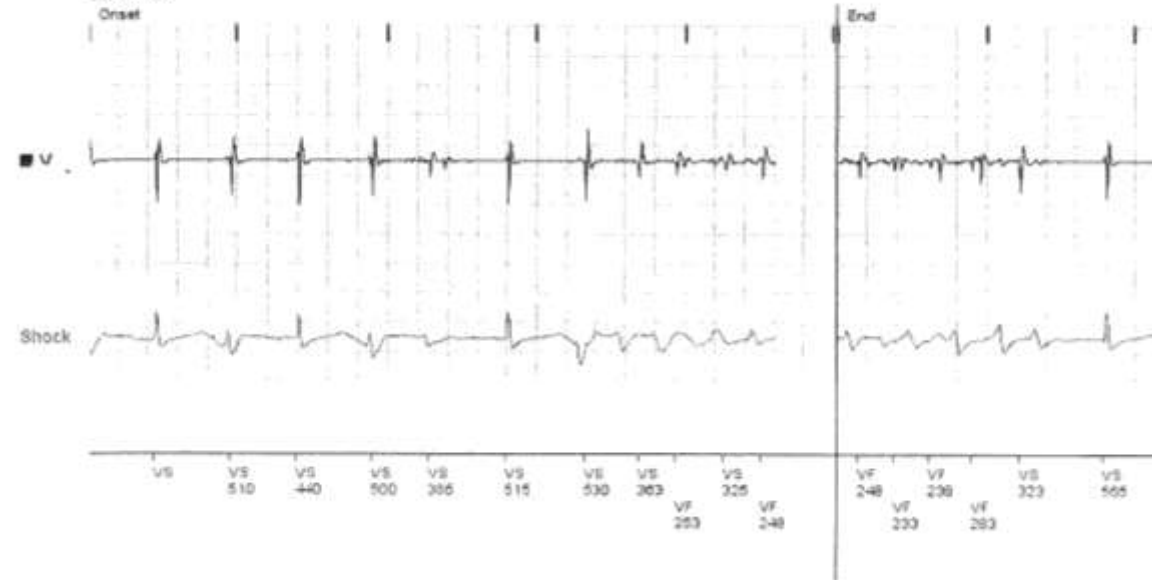
Event V-8 21 Jul 2010 06:58

NonSustV Event Onset  
 Avg V Rate  
 Detection

228 min<sup>-1</sup>  
 Rate Only

Event Ended 00:00:05

25 mm/s



# Conclusions

Remote monitoring of pacemakers and defibrillators is an attractive new technology;

Setting it up takes extra staff time, although less may be required when it is running well

# Conclusions

Wireless technology offers more flexibility than does wanded transmission

GSM technology may be preferable to analogue phone lines, allowing continuous monitoring (with a mobile transmitter) but is probably more expensive

# Conclusions

The size of the implanted devices may limit use in small children

Lack of problems, and need for clinical follow up unrelated to the pacemaker may also reduce its utility in children with pacemakers

# Conclusions

Children with ICDs may benefit, but require access to their transmitter at regular and predictable times