

# Diagnosis of Atrial Fibrillation by Means of Implantable Devices. The Role of Remote Monitoring

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## Abstract

*Atrial fibrillation (AF) is responsible for most hospitalizations for arrhythmia and is an independent risk factor for stroke. The cardioembolic stroke is frequently related to the presence of AF in any form (paroxysmal, persistent, permanent) and is characterized by high mortality and high residual disability. The clinical history of patients implanted with PM / ICD is often characterized by new occurrence or the recurrence of AF. We evaluated the role of remote monitoring of implanted devices for accurate detection of symptomatic or silent AF especially when there is an atrial electrode.*

*Out of the 3876 patients followed in our laboratory, 699 (18%) were managed through remote monitoring systems. Automatic alerts of the remote monitoring systems were set to early detect and track AF episodes by using algorithms capable of measuring the daily burden, the length and frequency of AF episodes and the ventricular response in some device models.*

*Transmissions (about 96,000/year), are evaluated, assessing the severity of the alarms, for the optimal therapy management with a workload of 435 and 87 hours/year for nurses and cardiologists respectively. Ambulatory examinations were reduced by 9.9% and also mean time dedicated to each patient was significantly reduced.*

## 1. Introduction

Atrial fibrillation (AF) is responsible for most hospitalizations for arrhythmia and is an independent risk factor for stroke [1-2]. The cardioembolic stroke is frequently related to the presence of AF in any form (paroxysmal, persistent, permanent) and is characterized by high mortality and high residual disability. The clinical history of patients implanted with PM / ICD is often complicated by new occurrence or the recurrence of AF. Nowadays technology allows to remotely control implanted devices by automatic transmissions at a predefined timing or by patient transmission in case of symptoms through modem and wired telephone lines.

More recently, devices communicate relevant data

wireless at a predefined timing or on automatically detected alarms without intervention of the patient. Remote monitoring has become the standard of care for cardiac device patients. Moreover implanted devices can easily detect atrial fibrillation [3-4], so we evaluated the role of remote control / monitoring of implanted devices for accurate detection of symptomatic or silent AF, in our settings.

## 2. Materials and methods

Out of the 3876 patients followed in our laboratory, 699 (18%) were managed through remote control / monitoring proprietary systems of Medtronic, Biotronik, Boston, St Jude and Sorin manufacturers with several modalities (Table 1).

System data available by remote monitoring for physician evaluation according to manufacturers are shown in Table 2.

The strategy adopted in our center include nurses in charge of giving transmission instruments and training to the patient and to the caregivers, usually 10 days after device implantation, and evaluating transmissions (about 96,000/year), assessing the severity of the alarms, consulting the cardiologist when needed and collaborating with him for the patient communication and the therapy management (Figure 1-6).

Manufacturer/model	N	Transmission frequency
Medtronic/ CareLink	279	Programmed Follow-up
Biotronik/ Home Monitoring	245	Daily Follow-up
Boston/ Latitude	86	Programmed Follow-up
St Jude/ Merlin	79	Programmed Follow-up
Sorin	10	Programmed Follow-up

Table 1. Number and properties of the implanted devices in our settings having remote control / monitoring capability.

- Battery status
- Charging time
- Device check
- Device fault
- Asynchronous stimulation
- Therapy status changes (Monitor, OFF, ON)
- Leads Impedance Trend and Out of Range;
- Lead Integrity
- Sensing Values
- Thresholds Values
- AF episodes
- Arrhythmic events
- ICD shocks
- Heart failure diagnosis
- ST segment elevation episodes

Table 2. Available data by remote monitoring system (device, leads and clinical check)

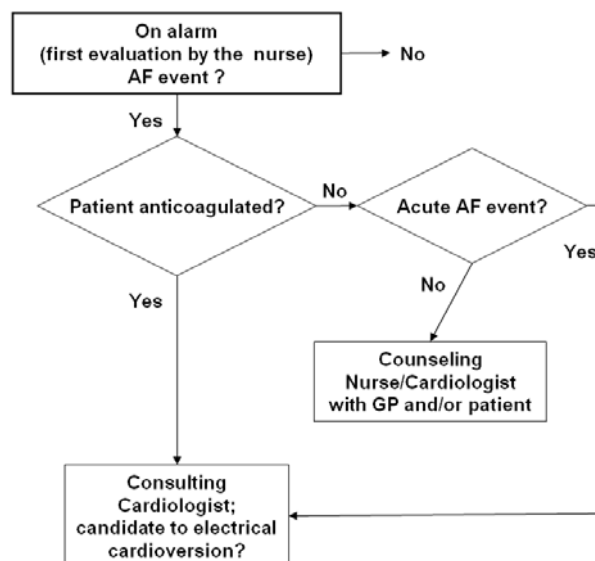


Figure 1. Simplified protocol for the management of atrial fibrillation (AF) events. GP=General Practitioner.

<b>Implant</b>				
				Off
				Special implant status, Ven. detection off, Emergency brady active, Back-up mode, EOS
				ERI
				Programmer triggered message received
<b>Lead</b>				
				Off
				RA pacing impedance < 250 ohm or > 1500 ohm
				RA sensing amplitude (daily mean): < 0.5 mV
				RV pacing impedance < 250 ohm or > 1500 ohm
				RV sensing amplitude (daily min.): < 2.0 mV
				RV pacing threshold safety margin: < 1.0 V
				LV pacing impedance < 250 ohm or > 1500 ohm
				LV sensing amplitude (daily mean): < 2.0 mV
				LV pacing threshold safety margin: < 1.0 V
				Daily shock lead impedance < 30 ohm or > 100 ohm
				Shock impedance < 30 ohm or > 100 ohm
<b>Atrial arrhythmia</b>				
				Off
				Atrial burden > 25 %
				Long atrial episode detected
				Atrial monitoring episode: every
				SVT detected: every
<b>Ventr. arrhythmia</b>				
				Off
				VT1 detected every
				VT2 detected every
				VF detected every
				Ineffective ven. max. energy shock(s)
<b>HF Monitor</b>				
				Off
				CRT pacing < 85 %
				Mean ven. heart rate > 80 ppm
				Mean ven. heart rate at rest > 80 ppm
				Mean VES / h > 50 VES / h
<b>Episode</b>				

Figure 2. Example of automatic alerts settings of the remote monitoring system to early detect and track atrial fibrillation episodes.

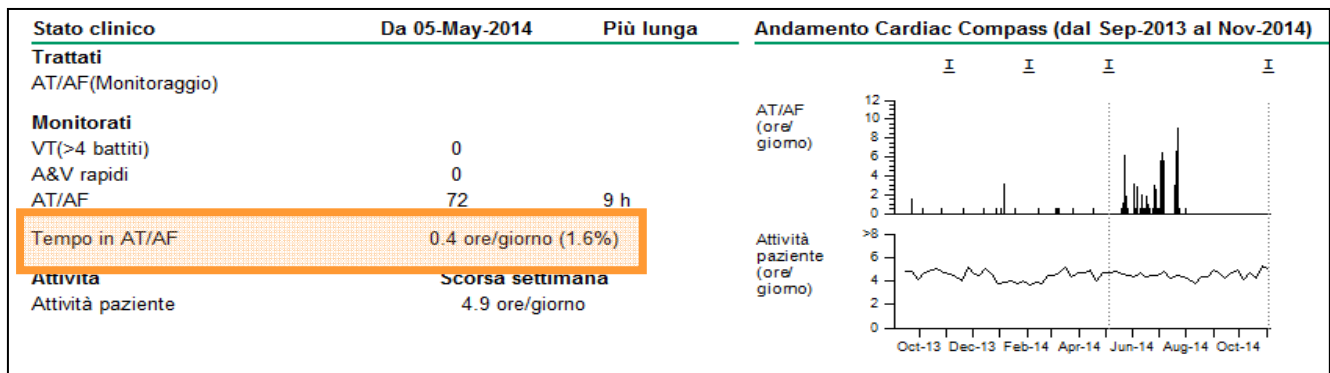


Figure 3. Burden estimation. Time in atrial fibrillation (AF) 0.4 hours/day in this example.

<b>Mode Switches: 218 (Percent of Time: 1.8%)</b>					<b>Atrial Arrhythmias</b>	
<b>Atrial High Rate Episodes: 111</b>					<b>Duration</b>	<b>Count</b>
<b>Episode Trigger: Mode Switch &gt; 30 sec</b>					= >72hr	0
<b>Date/Time</b>	<b>Duration</b> hh:mm:ss		<b>Rate (bpm)</b>		24hr - <72hr	0
			<b>Max A</b>	<b>Max V</b>	12hr - <24hr	0
10/04/14 1:14 PM	:02:05	First	218	132	4hr - <12hr	0
10/06/14 10:37 PM	:05:39	Fastest	>400	108	1hr - <4hr	0
10/17/14 1:38 AM	:43:52	Longest	362	115	10min - <1hr	30
11/05/14 5:38 AM	:54	Last	196	107	1min - <10min	67
<b>Ventricular High Rate Episodes: 0</b>					<1min	121
						218

Figure 4. Longest single atrial fibrillation episode.

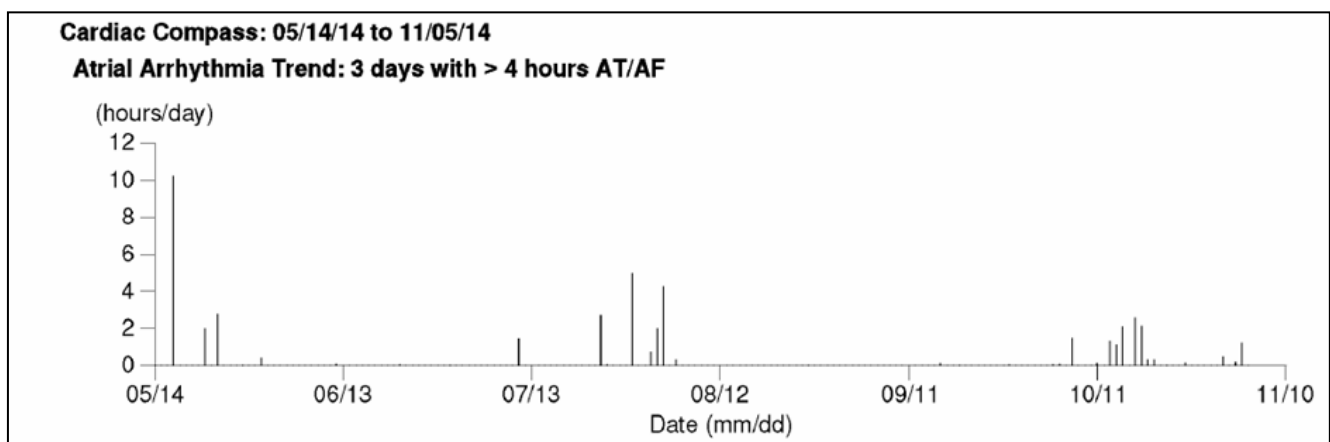


Figure 5. Atrial fibrillation (AF) episodes frequency.



Figure 6. Example of atrial fibrillation detection on a endocavitary tracings (arrow).

### 3. Results

Automatic alerts of the remote monitoring systems were set to early detect and track AF episodes (Figure 2). Dual-chamber devices are able to acquire and to process the electrical activity of the chamber directly, so AF episodes are detected by standardized algorithms capable of measuring the daily burden (Figure 3), the length and frequency of AF episodes (Figure 4-5) and the ventricular response. In single chamber devices there is no lead in the atrium so the presence of AF can only be derived from the instability of the ventricular rhythm. Remote monitoring can transmit endocavitary tracings that allow the operator to verify if AF is in progress (Figure 6).

For the management of the remote monitoring system the workload of the staff was: 435 and 87 hours/year for nurses and cardiologists respectively (Table 3). Ambulatory examinations were reduced by 9.9% (year 2014 vs 2013). Mean time for routine clinical examinations resulted 6 vs 15 minutes/patient because tracings and parameters were already collected.

### 4. Conclusions

Remote monitoring can reduce the incidence of inappropriate shocks for ICDs and overall hospitalizations for stroke and arrhythmias thanks to the early recognition of the AF episodes. Moreover AF entail important and serious consequences both from the health and socio-economic point of view. In our approach the nurse is the protagonist in the management of arrhythmic events and may require the intervention of the cardiologist in case of clinical instability. This requires a high clinical expertise to identify arrhythmic events and

implement the actions prescribed by the cardiologists. Nowadays, the technology is an indispensable tool for the patients management. It allows to reduce ambulatory examinations and staff time dedicated to each patient.

	Number	Nurse time (hours/year)	Cardiologist time (hours/year)
Implanted devices having remote monitoring	699	141 <sup>(*)</sup>	
Routine transmissions	95.720	71	11
Alarms	3.542	153	53
Patient/GP call	319 <sup>(**)</sup>	70	23
Total time (hours/year)		435	87

Table 3. The workload of the staff. (\*) delivery time and process education. (\*\*) alarms that required medical attention. GP=General Practitioner.

### References

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